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GERMANY AT THE WORLD'S COLUMBIAN EXPOSITION.

IF what is written over the Bavarian pavilion in the Palace of Manufactures and Liberal Arts applies to the German people, they must be the most powerful and worthy of respect of any nation in the world. "Art and Trade, the People's Strength," is the legend we find written there, and surely no other exhibiting nation has shown anything comparable with this exhibit of art and industry. The German section stands here at the intersection of the two main aisles of the immense Manufactures and Liberal Arts building, directly opposite the three nations which rank next in the world of art and trade, England, France, and North America, and even the representatives of these three nations recognize the superiority of the German division. No single section has such a picturesque ensemble, or a structure that is so beautiful, architecturally, as the German, and the visitors to the building descry the German exhibit from a distance on account of its monumental beauty. Former expositions have had more or less of the character of a world's fair, but, generally, people have been contented with a row of simple show cases without any architectural decoration. This will no longer fulfill modern requirements. Luxury has made itself prominent in even the industry expositions, and elaborate decorations are necessary in order to win approval of the masses.

Fortunately, everything was at hand for an imposing structure; Begas' magnificent group, "Germania," from the Reichstag building, and the beautiful iron work of the firm of Armbruster, of Frankfort a. M. The latter, with the three artistic gates, separates the court of honor of the German section from the main aisle of the Manufactures building, this court being, in turn, inclosed on either side by charming pavilions and halls crowned by towers. Many artistic objects of the exhibit have been used for the decoration of this main court; for example, the background of this court is formed by the exhibit of the Berlin Imperial Porcelain Works; the altar-like structure in the center, with the twisted columns supporting the roof, contains the large allegorical picture by Professor Kips, representing the glorification of "Germania" with her most celebrated sons. Behind this masterpiece of porcelain painting are arranged a bath room and other rooms to which two winding staircases lead, with beautiful wrought iron balustrades; between the two arms of the staircases rises a monumental bronze fountain.

The arcades on both sides of the main court serve for the exhibition of art treasures from Baden and Bavaria. In front there is only the ornamental wrought iron work. The connecting walls between these arcades and Kip's central picture are ornamented with objects from the Berlin Porcelain Works, among which is the portrait of the Emperor and a great porcelain fireplace with ornamental figures, and beyond a toilet table with a large mirror. The court itself is filled with show cases, which contain magnificent presents belonging to the German sovereigns and gifts to Bismarck and Moltke—all celebrated works of German art industry.

Unfortunately a rather obscure little place has been given to the Royal Porcelain Works of Saxony, which can well claim superiority, and therefore the elegance of form and skillfulness of execution of the unsurpassed objects cannot be appreciated as they deserve. The masterpiece of this section is the jewel case, worth $1,900, made of ebony with plates of porcelain inlaid, the plates being decorated with allegorical pictures. A pair of dark blue vases, three feet high, are decorated with platina paintings, and near by are great candelabra decorated with figures and flowers, little lamps, boxes, picture frames, mirrors, and chandeliers of rare delicacy and beauty of coloring. The most beautiful article is, without doubt, a large toilet glass with table, all of porcelain and with beautiful flower decorations. The price of this piece alone is $3,800.

Hidden in a labyrinth of courts, the entrances of which are difficult to find, are exhibited a multitude of beautiful products of art industry, which, unfortunately, are not so arranged as to be properly seen. Only the outer parts of the German exhibit, which open on the main aisles, show to the best advantage. The colossal group "Germania" rises prominent above all, and one of the most striking objects in the Manufactures building.

No foreign section in the Chicago Exposition is so rich as that of Germany, and never before was the German empire so well represented at an exposition. While, for instance, only 700 exhibitors took part in the Philadelphia Exposition, there are over 6,000 at the Chicago Fair, and even "Germans" are surprised at all the beautiful objects that have been brought from the fatherland. It might almost be said that one must go to Chicago to learn to know German art and industry.

The foregoing is the substance of an article by V. Hesse-Wartegg, in the *Illustrirte Zeitung*, and we are indebted to the same paper for our illustrations, which are from the pencil of C. Limmer, special artist.

THE WORLD'S COLUMBIAN EXPOSITION—THE GERMAN EXHIBITS, PALACE OF MANUFACTURES AND LIBERAL ARTS.

NOTES FROM THE GREAT EXPOSITION.

THE *N. W. Lumberman* has some good things about the Fair, from which we take the following:

GOVERNMENT FORESTRY EXHIBIT.

Among the important features of the World's Fair exhibit made by the division of forestry of the United States Department of Agriculture, is its forest botanical display. The space devoted to this department is considerable, but entirely commensurate with its important bearing upon practical and theoretical forestry, as well as its educational bearing.

Forest botany is a branch of the general science which has received but little attention in this country, apart from the study of other plants. It is a fact, however, that our extensive forest flora furnishes one of the most interesting and economically important sub-

jects for investigation to which the student of nature may turn his attention. Few botanists are as intimately acquainted with the trees they meet as with the more lowly forms of vegetation; but if this is due to a lack of appreciation on the part of botanists, it is certainly true that there are few plants concerning which the general public appreciate information so keenly as that upon the trees which adorn our streets and parks and clothe with their majestic forms our mountains, hills and plains.

We are pleased, therefore, to note the care and evident pains that have been taken to illustrate by well grouped specimens a large number of our most valuable forest trees. A unique series of monographs of 20 representative and economically important species is exhibited on a large scale, giving almost at a glance a complete history of each species from its tiniest beginning to its mature and useful size. A series of panels 3 feet wide and 12 feet in height are grouped together in the form of massive cases. Each panel is surrounded by a broad rustic frame of flitches cut from the mature trunk of the species represented, displaying amply the characteristic appearance of the bark. Within the frame are five divisions in which are successively illustrated: first, a full sized cross section of a mature and a smaller sized trunk, together with rough sawed samples of the timber as it is used in construction; second, a finished and polished panel of the wood is seen in transverse, radial, and tangential section, exhibiting all the natural beauty of the wood; third, a complete display of the botanical features is found in the form of a large spray with flowers, mature foliage and fruit, to which is added seedlings ranging from germination to three or four years of age; fourth, in large type occurs the accepted common and botanical name with exhaustive synonyms of vernacular and botanical names. The chief economic uses and quality of the wood are also detailed with figures for specific gravity and resistance to the various mechanical strains; in the fifth division is a graphic illustration of the geographical distribution of the species, special attention being given, in the case of the pines, to the comparative density growth.

A much more extensive exhibit of about 250 species of forest trees is seen arranged on a series of large screens or panels. A glass covered case (12 × 16 inches) contains a full display of all the botanical features of each species, and a plainly printed label gives the common and scientific names, together with a concise statement of the geographical distribution. The cases are arranged around the margin of the screens so as to give a comparative view of all the species shown from the same family or genus. In the center of the screen blocks of wood are shown corresponding to each case of botanical specimens. A reduced map of North America also accompanies each specimen of wood and shows at a glance the geographical range of the species. A printed paragraph at the bottom of the map gives the habitat and size attained by each species, together with the quality and principal commercial uses of the wood.

The seeds of 200 important native forest trees species are displayed in an octagonal column, and the grouping of allied genera affords an interesting comparison of seed characters. A broad terraced base surrounding the column exhibits, in the living state, about fifty different species of native conifers, ranging from the germinating seedling in the top terrace to young trees 18 inches in height in the lower bank. The southern pitch or long leaf pine, so rarely found in cultivation, may be seen as it appears from two months to six or eight years old. This species is especially interesting and different in its growth from other pines during the first three or four years of its growth—during this time a mere brush of long leaves appearing above ground, while the main energy of the plant is expended in the development of an enormous root. From the fifth year on the trunk begins to grow in height, after the manner of other pines.

LECTURES ON FORESTRY.

Alfred B. King, commissioner from Liberia, recently gave his talk on the forests of West Africa. It was his opinion that some time would elapse before the subject of West African forests could be properly treated. The coast territory he said had been entirely devastated, and was now covered with a new growth of timber. The soil of this country is so rich that remarkable growths of trees are to be noted, some growing to a height of fifty feet in seven years. The most numerous tree in Liberia seems to be the palm, one variety of which is supposed to be the "shittim" wood of Holy Writ. The fiber of this tree is used for certain purposes, but as a commercial wood it doesn't seem to stand very high. Mr. King spoke of gum and resin trees, but made no reference to their commercial value as lumber. Mahogany, cedar and black gum grow in the forests of West Africa, and according to Mr. King there are at least 37 different kinds of hard wood. The rubber is one of the most valuable native trees.

Robert Hudson gave a very entertaining talk on the forests of New South Wales. The forest preserves of that territory cover 5,000,000 acres, divided into 1,013 districts, each having a resident forester, whose duty it is to protect the precincts under his care. The forest acreage of New South Wales is estimated at 21,000,000 acres. Red cedar is used for railroad ties, street paving and in building. A wood known as "iron bark" is used for timbers, dimension stuff and also for ties. A specimen of this wood may be seen in the Transportation building at the Fair which had been used for 25 years before being brought to this country. Another wood known as "stringy bark" is used for house material, the trees reaching a height of 150 feet, with a diameter of two and three feet. Mr. Hudson extolled the durability of red cedar and referred to the log to be seen in the Forestry building in the exhibit from New South Wales, which had been felled for more than 30 years, covered by floods, debris and mud, and which is apparently uninjured. In the same exhibit may be seen samples of red and black bean, a beautiful wood susceptible of a high degree of finish. New South Wales imports considerable wood annually, Mr. Hudson admitting that the timber of Oregon was largely depended upon on account of its great length and light weight.

The paper of Prof. William Saunders, director of the Dominion experimental farms at Ottawa, Canada, contained considerable information about Canadian timber lands. The wooded portions of Prince Edward's Island he said contained white and black spruce, American larch and some oak. In the Province of Quebec the principal timber, of course, is white pine. Timber laws prevent the felling of small trees. There are also stringent regulations for the prevention of forest fires. Inspectors appointed by the government visit the lumber camps from time to time to see that the laws are enforced. Nova Scotia possesses large quantities of pine, oak, elm, maple, beech and birch, and with so much native timber, little feeling exists in regard to tree planting. Ontario derives great revenue from its timber exports. Manitoba is largely treeless. British Columbia is heavily timbered and has an area of 380,000 square miles. Much of the timber land of this region is valuable. Along the west range of mountains there is a continuance of the big trees of California, Oregon and Washington, and the timber is quite similar to that of the three States named. The paper of Prof. Saunders contained an interesting account of how trees are planted in the Dominion of Canada and in other British possessions.

An able address was delivered by J. E. Defebaugh, editor of the *Timberman*, of Chicago, on "Forest Culture from the Lumberman's Standpoint."

The lumberman, Mr. Defebaugh said, had been charged with being a ruthless destroyer of our forests, yet he has as acute a perception of the needs of posterity as any one living. He who lives by converting timber into a commercial product is no less a man than he who for a salary delivers lectures on climatology or botany. He deplores the blackened wastes which follow the operations of his logging crews as heartily as any one. He is more keenly alive to the ravages of forest fires than is any forest enthusiast, for they not only have a sentimental interest for him, but a practical one, as they may wipe out the investment which represents many years of active business life. The lumberman is in the business of lumber manufacturing, or the converting of timber into a merchantable commodity which is demanded by the people of the country. He has his money invested in lands, in timber appliances for bringing his timber to the point of manufacture, in mills, and in all the paraphernalia for the conduct of the lumber business, and cannot be blamed for the conditions under which he is operating.

This country is not yet old enough, the conditions marking the lines along which business is conducted are not well enough defined, and the whole business fabric is not stable enough to allow the country at an early date to enter upon any well-defined policy of forestry culture or preservation. While our population is increasing so fast by means of immigration, and while there is such a demand for the development of natural resources, when would-be settlers are clamoring for land and as urgently demand cheap building material with which to shelter themselves, their families and their stock, it is hardly practicable to take the conservatory steps necessary to yield any marked results in the line of forest preservation. What is wanted is a commercial conservation of the forests, but this involves conditions so different from those now prevailing that it is difficult to see how any immediate headway can be made. But agitation for anything theoretically desirable is a good thing, for the dream of one generation is the reality of the next. Conditions are shifting fast in this new country of ours, and the next fifty years are likely to show great changes in fundamental things.

THE WORLD'S COLUMBIAN EXPOSITION—EXHIBIT OF THE ROYAL PORCELAIN WORKS OF SAXONY.

The conclusion so far as the lumberman is concerned seems to be plain and inevitable that it is not, under present conditions, within his power to carry out any policy of forest preservation or culture. We are obliged, therefore, to fall back on government control. The lumberman has no objection to this, for he is persuaded that the foundations of our commercial fabric are so well laid as to guarantee that his possessions shall not be taken from him except at a fair valuation; and he will have no objection to the government withholding from sale any timbered lands now remaining under its control. In fact, such a removal from the market of cheaper timber lands would enhance the value of his holdings.

The lumberman will, moreover, have no objection to governmental regulations which shall require him to clean the land on which he conducts his logging operations of the debris remaining therefrom; but he would insist that such regulation should be established and enforced by the government and applied impartially to all sections, as otherwise an artificial inequality would be brought about. State regulation will hardly answer, for stringent enforcement of rules in Wisconsin may put the operator in that State out of competition with his competitor in Minnesota or Michigan. It may be that the general government has no authority to exercise such police power, but it is difficult to see how State authority could accomplish the object desired without doing injustice to lumbermen in some sections.

THE FERRIS WHEEL AT THE WORLD'S FAIR.—*From Electricity.*

FRENCH EXHIBITS.

Since France has become a republic she has very properly taken on the ways of a republic. Other nations come here and make a show evidently to impress us with their power and wealth. France is after what there is in it in a commercial way. No other nation shows so much that the women of the world will buy. Imagine the elegant features of a dozen of the finest dry goods stores combined, and such a combination would, in part, cover the French exhibit. Even the exterior of the court has commerce and trade written all over it. There are no portals to pass before the visitor may see in part what France shows. One may walk along Columbia avenue and see behind the big plate windows of the court enough to make a millionaire's pocketbook ache provided his wife could get at it and buy all the goods she wanted of the artistic Frenchmen. In one window there are fifteen dresses, on models. We can't say how much these dresses are worth; neither can we describe them. It would take a society reporter to do the latter, and even he would have to go slow or he would lose his bearings. A quarter of a million of ladies have stood before these dresses and exclaimed, "Oh, my!" and "How lovely!" If a man sees them at all, he is obliged to push his way through a solid mass of women, stepping on their feet and on their long skirts, ripping them from their anchorage, and by the time he gets out of it he feels pretty cheap. Then when he is pushing his way through, some of the ladies look at him as much as to say, "You great coarse thing, what are you intruding about here for?" All that discourages him, and the men have about concluded that their place isn't even within seeing distance of the French dresses. One thing about these French dresses you will notice—they make the ladies who wear them hold their heads high. It is just about like putting check reins on them. These wide ruffles are worn at our fashionable centers to a considerable extent, but over in Paris they have got it very bad.

They also wear corsets in France, and there is a string of them here so nicely trimmed with gimp and silk and little golden stars that if a country girl should get one of them on she would feel like a colt.

In tapestries the French are also to the front. There is one piece hanging on the wall that represents the labor of one man for thirty-six years, and is valued at $200,000. This, and another one hanging opposite, and of about the same quality, belong to the French government. For a few thousand dollars you can buy one large enough to hang in your parlor. These tapestries are very deceiving, in so much that a short distance away they would be taken for oil paintings.

The furniture exhibit is exceedingly fine. And in connection with the show of furniture generally, we notice that not one piece made of light wood has been brought from abroad. Here we have tabooed dark wood for furniture purposes, but the foreigners show either dark wood or gilt.

From the main floor French exhibit two stairways lead up to the display of silks, satins and velvets. This show room is 60×300 feet, the carpet of mahogany colored velvet, and valued by the United States customs house inspectors at $15,000. There are elegantly upholstered seats which will accommodate 100 people or more, and on these seats men, women and children worn out from seeing the Fair may be seen sleeping at any time after the morning hours. You might think by this that it is very quiet up there. So it is. This little corner of the great Exposition which contains the largest and richest display of the rare product of the looms of France ever shown will be seen by comparatively few people. That your wife may not miss it is the excuse for mentioning it here.

TESTING AN AMERICAN SAW MILL.

The people who had gathered in the Stearns mill saw a performance that was not on the programme. The commissioner of the Argentine Republic brought a good many specimens of wood to the Fair in the shape of logs, and these logs he wanted cut into halves. How to do it was a problem that bothered him. Our mill men are not used to such timber as grows in that portion of South America, but Manager Griswold said he would give it a whirl anyway. The log haul-up was set in operation, and when the mill was ready to start up there were fifteen logs lying on the deck, ranging in size from a foot in diameter and three feet long to two and one half feet in diameter, eight or ten feet in length.

Literally it was a hard lot. There was lignumvitæ and ebony, and that is about as far as anybody present could name the kinds. Evidently every stick had been cut since the date the news reached South America that there would be a World's Fair. Worms had eaten holes through the bark of some of the logs, but there their ravages ended. They could make no impression on the wood itself, and in an attempt to do so butted their worthless brains out.

When the Garland "kicker" pushed the first log on to the carriage it fairly scringed from pain. It had never before tried its strength on anything so hard. Hill's "nigger" next took a hand and came up through the floor with all the confidence that it would were there a pine or hemlock log on the carriage, but its teeth did not get a hold farther than to tear the bark. Nothing discouraged, it dropped back into its hole, spit on its hands, flew up and hit the tropical log in a way that made it spin like a top.

The sawdust from the first log was as yellow as saffron, from another it was pink, and from another red. One stick when opened out was nearly as white as holly, but as hard as Pharaoh's heart. Probably no sawyer ever before handled the lever and guided his saw through so many different woods in the same length of time. It was thought by some to be an uncalled for test of the mill, as it might result disastrously, but there was not a hitch in the performance. The saw used was an Emerson.

THE FERRIS WHEEL.

THE Ferris Wheel, the crowning engineering feature of the Columbian Exposition, was lately thrown open to the public before a large audience of invited and distinguished guests. Over five thousand people were present to see the enormous body of iron make its formal turn for the public pleasure and comfort.

The wheel is certainly one of the most remarkable structures that have ever been designed or erected. As the Brooklyn Bridge and the Eiffel Tower have been as milestones to mark the progress made in engineering in the past, so will the Ferris Wheel be added to mark another advancing step. The Ferris Wheel is to the Columbian Exposition what the Crystal Palace Hall was to the Crystal Palace Exposition, or the Eiffel Tower to the Paris Exposition. Although the electrical features of the wheel are of a secondary nature, the wheel itself is deemed of sufficient importance to warrant a short description in these columns.

The highest point is 265 feet above the surface of the earth. The diameter is 250 feet and the circumference 825, the entire wheel being raised 15 feet above the ground.

In reality there are two wheels thirty feet apart.

These twins are connected by iron rods and struts which do not approach nearer than twenty feet to the periphery. Outside of these rods the cars are hung and supported by steel bars of about five inches in thickness extending from one wheel to the other. Each wheel has for its outline a curved iron beam 25½ by 10 inches. Forty feet inside is another beam, forming a smaller circle. From these beams or circles extends the massive iron trusswork which holds them together.

The axle on which the great wheel turns is a steel bar 32 inches thick and 45 feet long. It is fastened to each of the twin wheels in a steel hub 16 feet in diameter. All of this great mass, the hubs and the two circles, is held together by 2½ inch steel rods arranged to run in pairs from the axle to spread 13 feet apart at the circumference.

There are thirty-six cars on the wheel, each capable of comfortably seating forty people. The cars are 27 feet long, 18 feet wide and 9 feet high, and each one weighs 18 tons.

The wheel, with its passengers, weighs 1,200 tons. The whole thing rests on two pyramidal towers at the axis. The towers are 140 feet high, 40 by 50 feet at the base and six feet square at the top. Each tower has four feet resting on twenty-foot cube concrete foundations. Underneath these are crossbars of steel. The motive power comes from a 1,000 horse power steam engine under the wheel. It will find no difficulty in revolving the wheel and the passengers as fast as the latter want to go. There is an automatic air brake on, however, to regulate the speed and stop everything in case of danger. The wheel is moved by cogs on the periphery passing over a chain that looks like a mammoth bicycle chain. In the construction every precaution has been taken against accident.

The illumination of the wheel will be effected by arranging 300 incandescent lamps around the periphery on each side, and 360 lights on the cross beams. One hundred or more lamps will be placed in the form of rosettes on the axle. The legs and foundations will be wired for 500 lamps. A space of eighteen inches on the shaft has been reserved between the bearing and the hub for the collector rings, which will be similar to those used on alternating dynamos.

Current is to be furnished from a small plant in the boiler house, located about 400 feet from the wheel. The lighting plant will consist of a 150 horse power Ball engine and an Edison dynamo.

In order to prevent accidents by starting the car before the gates or doors are closed, a very novel electrical arrangement has been introduced. A six-point annunciator is mounted on the engine in full view of the engineer. Each drop is wired to one of the gates in such a manner that as soon as it is opened the pointer will indicate its position and the engineer will understand that the wheel cannot be put in motion.

The company has a plan under consideration for introducing a telephone system, so that each car will be in direct communication with the engineer.—*Electricity.*

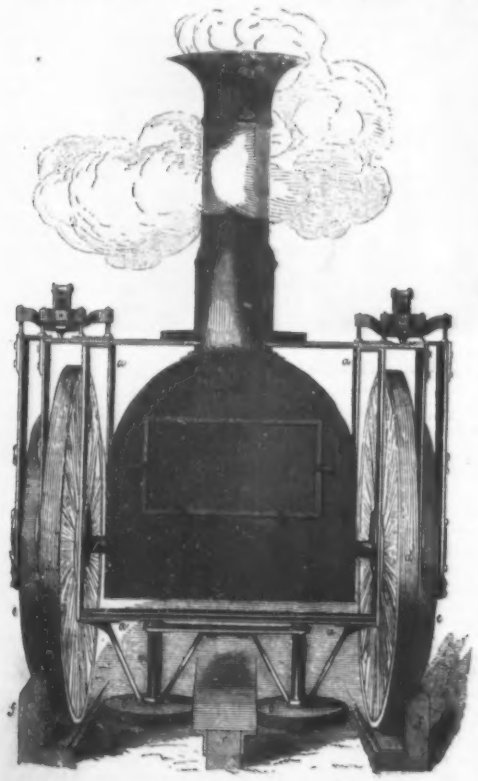
KOLLMAN'S LOCOMOTIVE RAILWAY APPARATUS.

IN 1845 a London paper called the *Pictorial Times* published the engravings we herewith reproduce, and also the following particulars:

The proposed advantages sought to be obtained by Mr. Kollman's system may be thus briefly and popularly stated.

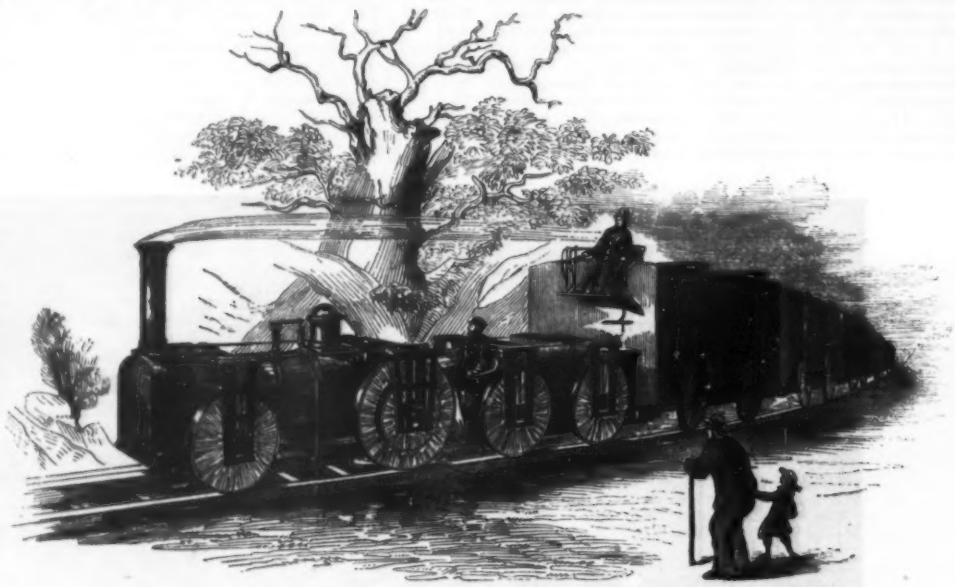
I.—COMPLETE SECURITY FROM OVERTURNING OR RUNNING OFF THE RAILS.

In the ordinary mode the train is kept on the rail by its weight, and secured to it by the rims or flanges placed on the inner edges of the wheels. This, in practice, as is well known, is attended with great friction, and consequent loss of power; serious abrasion of the metal of the rail, and great danger in passing curves at high velocities. In Mr. Kollman's mode the maintenance of the moving carriage on the rail, by means of such flanges, is abolished, and the wheels are made to run in a precisely similar manner to those of ordinary carriages, and therefore perform their duty free from lateral pressure or friction of the flanges against the rails. They have, in fact, no flanges. The mode of guiding and securing them in their revolutions on the rail is by means of horizontal wheels fixed to movable axles, which, as the carriage runs, act against the sides of a supplementary rail, placed midway between the bearing rails. In this way the carriages are securely fastened to the roadway; and it follows, that they cannot run off the rails or overset.



a a a a, the frame in which the engine is suspended; *b b*, the horizontal guide wheels; *c*, the guide rail; *d d*, the bearing wheels; *e e*, the serrated wheels attached to the bearing wheels; *f f*, the raised rails on to which the smaller wheels, *e e*, act when ascending an incline.

END VIEW OF KOLLMAN'S LOCOMOTIVE ENGINE.



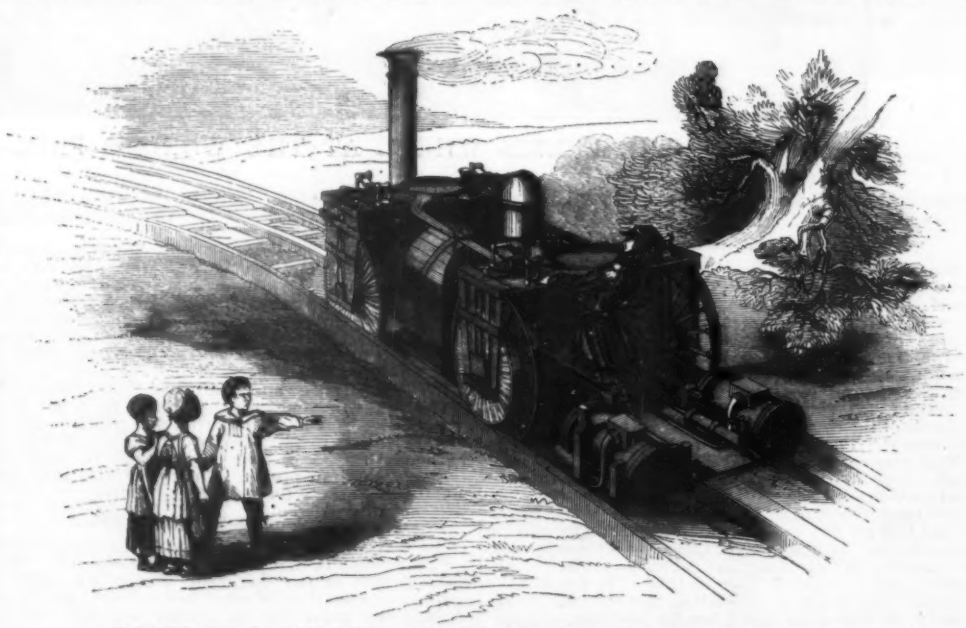
TRAIN OF KOLLMAN'S ENGINE AND CARRIAGES.

II.—THE POWER OF TRAVERSING CURVES OF ANY REQUIRED RADIUS WITH SPEED, DIMINUTION OF FRICTION, AND INCREASED SAFETY.

To permit a train of wheels to pass a pair of curved rails with ease and safety, it is necessary they should be so yoked together as to act independently of each other—that each one should have the power of freely adapting itself to the curve of the rail; but in the ordinary system the whole of the wheels being fixed on unaccommodating axles, and bound by an inflexible framework together, all work alike; and it follows sometimes that while one wheel is revolving smoothly and without obstruction, the other is hissing, grinding, and tearing away the surface of the companion rail—or, worse still, twisting the axle to which it is fixed, as a preparation for the future downfall of a train. Mr. Kollman proposes to remedy these evils. We shall let him describe his invention in his own words. He says: "The difficulty in passing over curves of moderately small radius in the ordinary mode of railroad appliances needs no argument. It is well known that reduction of speed is essentially necessary; that extreme wear and tear result to the locomotives and carriages by the grinding and sliding operation, produced by the transit of an inflexible frame, confined by flanges on the wheels, over a curved line, and between concave and convex surfaces, while their obvious tendency must be to fly off at a tangent from the curves; for the prevention of which, at any considerable speed, there is no adequate security. Mr. Kollman's system guards, as far as possible, against any such contingencies; it reduces the height of the center of gravity; diminishing the centrifugal force and atmospheric opposition, it affords the facility of working in the most advantageous manner for producing speed, by allowing of any requisite diameter to the wheels; at the same time it precludes the necessity of those formidable tunnelings and cuttings, which require such enormous outlay; and of traversing ornamental property, which is not only of necessity more expensive in the acquirement, but tends to obstruct, by powerful opposition, and render obnoxious the general adoption of railroad communication." These great advantages are to be secured by the suspension of the engine and carriages in frames working on pivots. In the case of the engine, the extremities of the frame—which would at the same time support the driving and bearing wheels—would acquire their direction in precise proportion to the curve, by horizontal wheels placed below the bed of the vehicle. The bearing wheels of all the carriages would be independent of each other. By this arrangement, not only would curves be traversed with greater facility, but a greater flexibility of motion would be obtained, and the carriages would accommodate themselves to the inequalities of the roadway.

III.—THE POWER OF ASCENDING AND DESCENDING INCLINES OF SUCH GRADIENTS AS HAVE HITHERTO BEEN DEEMED IMPRACTICABLE.

The capability of ascending inclines of steep gradients is obtained by means of wheels of smaller diameter, slightly serrated and fixed to the outer surface of the driving wheels. These smaller wheels come into action on reaching an incline, where a pair of elevated rails are laid down by the side of the bearing rails, of such a height as to prevent the larger driving wheels from bearing on them. By thus diminishing the diameter of the wheel, the power of leverage in the engine crank is very considerably increased, and a greater power of climbing the "hill of difficulty" is obtained. While the smaller wheels are actively "biting" the rail, the larger ones may act as bearers. In the old system of flanged wheels, Mr. Kollman thinks it would be very difficult, it not impracticable, to combine this power of surmounting heavy inclines at a diminished speed with



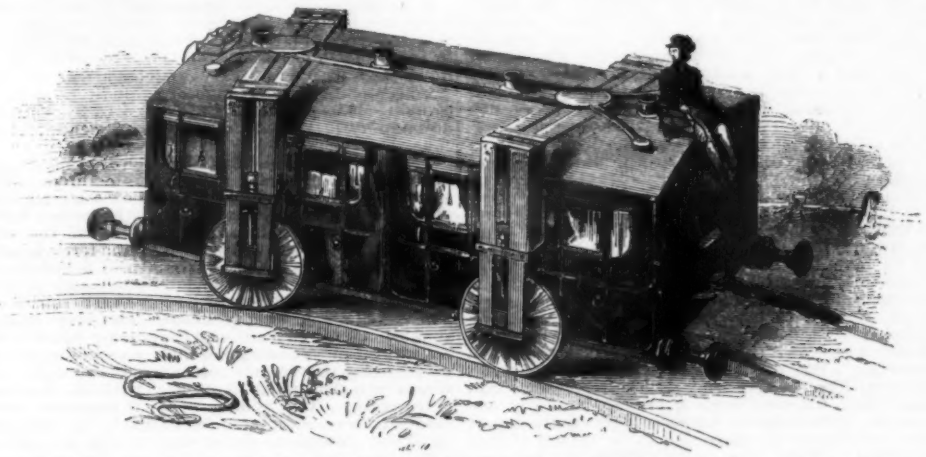
KOLLMAN'S LOCOMOTIVE ENGINE ASCENDING A STEEP INCLINE.

Showing, first, the elevated rails on which the smaller wheels act; and second, the improved position of the steam cylinders. These cylinders, which may be either fixed or oscillating, are so placed as to have a more direct and powerful action upon the axle than in ordinary locomotives, and, being near the rails, they bring the center of gravity of the engine proportionally lower.

the advantage of great speed on a level. It is true, that by diminishing the diameter of the driving wheels locomotives have been able to surmount comparatively heavy inclines; but in these cases it has necessarily required the sacrifice of a large proportion of speed throughout.

IV.—A SAVING OF EXPENSE IN THE CONSTRUCTION OF ROADWAYS AND CARRIAGES, ETC.—THE GENERAL WEAR AND TEAR.

With respect to economy, in addition to the above observations, it must be evident that the necessity of cutting, tunneling, embanking, and other engineering difficulties, being materially diminished, will obviate one of the hitherto most serious items of railway expense. The capability of traversing curves of any required radius will enable companies, in numerous instances, to avoid passing through parks, building land, and other property of great value, to be purchased only at enormous cost. A further source of economy arises from the flexibility of the new system, enabling the carriages to be constructed of a much lighter description than has hitherto been practicable; thus considerably reducing the dead or non-paying weight in each train, consequently a larger off-paying weight can be drawn by the same power of locomotive. The great annual saving thus arising from diminution in wear and tear of locomotives, carriages, rails, and other property, as above explained, is too manifest to require comment. In conclusion we may remark, it will be evident, that the mere production of any violent strain upon the plant must, in a general point of view, afford a liability to accident; but, by the proposed arrangement, the running off the line, to which in the present state of things there is so frequently a tendency, especially in curves of short radius, becomes next to impossible under any circumstances. The reduction of the center of gravity to so low a position precludes the liability to overturn; while the attachment of the train throughout its range to the guide rails, by means of the horizontal wheels, guarantees its security, unless the whole machinery were disrupted and displaced. The avoidance of that injurious and violent process of grinding and sliding on the rails, inseparable from the present defective state of things, involving as it does the unnatural expedients of coning the wheels, and giving undue and more dangerous play in their lateral range, must not be regarded as a trivial advantage; as by these means that oscillating and vibratory motion, peculiarly distressing to most passengers, especially to females, as well as productive of injurious results to proprietors, is entirely removed, and the carriages will be found to keep the even tenor of their way without swerving or jolting, however rapid the transit on the direct line, or on such a curve as might call into action centrifugal force.



KOLLMAN'S RAILWAY CARRIAGE TRAVERSING A CURVE OF SMALL RADIUS.

The wheels and axles are shown in the act of accommodating themselves to the curve.

SUGGESTIONS FOR MILITARY IMPROVEMENTS.

By Capt. CORNELIUS GARDENER, 19th U. S. Infantry.

THOSE of us who serve with troops, especially during campaign or service in the field, have frequent opportunities to observe wherein improvements could be made in the arms, equipments, rations and clothing for the army, as now provided. In some cases the improvements that suggest themselves in these may be but slight and not of vital importance, but we also have opportunity from experience with them to notice their more serious defects and to wonder why these defects should be allowed to exist. Outside of the army at least, the American people generally are ever ready to improve upon anything that stands in need of improvement, and they pay but little deference to any spirit of conservatism, especially when it blocks the way of utilitarianism. Yet it is a fact that, owing to a condition of affairs that need not be explained here, those who have the best opportunities to judge of the needs of the army in matters that pertain to its welfare and efficiency, both in peace and war, have least to say in bringing about improvements upon any existing status. The art of war is never at a standstill, and the nation which is in the advance of others in all that appertains to making its armies effective in time of war, be it even in the smallest details, is most likely to win. We should therefore improve in army affairs wherever we see opportunity for improvement, and not allow any spirit of conservatism to stand in the way of throwing aside useless hindrances to efficiency, and of adopting, from time to time, the new ideas which suggest themselves in the way of improvement, especially where they are sensible and of manifest utility.

To officers of the line, the arms, equipments, rations and clothing of the soldier are matters of vital importance. Upon these largely do we depend for success in campaign or battle, and like the poor, "they are always with us." Therefore it may be of interest to make a few suggestions with regard to them, which have occurred to the writer and possibly to others, and discuss wherein we believe improvements could be made in them as now issued, especially from the standpoint of common sense and utility.

First, ARMS, *The rifle and carbine.*—All officers wish their men to keep these in the best possible condition, both as regards the usefulness of these weapons and their appearance. The Ordnance Department insists upon, and has embodied it in the regulations, that nothing shall be done to improve the appearance of the stock. As received from the armory, the stocks of all rifles and carbines are of plain walnut, unfinished, soft and rough. Is there any good reason why the wood of the stock should not be filled and have a hard finish so that it will not be so easily indented, but will present a better appearance, and be more in conformity with the accouterments of a neat soldier?

As it is, about as soon as pieces are received from the armory, unless the captain is constantly on the alert to prevent it, men go to work in various ways by means of varnishes and shellacs to improve the appearance of the stocks and to make them more durable and impenetrable to water.

There is probably no small arms manufactory in the United States which turns out its rifles or shotguns in the same crude and unfinished condition as regards the stock as does the Springfield Armory.

In these arms, at present, the pull of the trigger is nine pounds or over. In the days of Frederick the Great, when Suabians and Walloons, ignorant and stupid peasants, were drafted in large numbers to serve as food for powder, there may have been some sense in having a nine-pound pull in order that the piece might not be discharged except by predetermined and strong effort. Our American soldiery, however, are senselessly handicapped by a nine-pound trigger pull.

No person wishing to purchase a rifle or shotgun for target or hunting purposes would ever think of getting one with such a pull. Three pounds is ample for all purposes of safety, especially in these days of brass cartridges and breech-loaders, and from the fact that a rifle is never loaded except to be immediately fired.

We all know how much practice it takes on the part of a recruit before he can keep his sight on the bull's-eye while pulling as hard as he can to fire the piece. This heavy pull handicaps even our best shots, our marksmen and sharpshooters; if not, why do good shots constantly endeavor to weaken the pull by filing the spring or by inserting pieces of leather, we all know where, to produce this effect? Are these men all wrong and the rifle all right, or is a nine-pound pull unnecessary and senseless? Another unnecessary handicap to good shooting is the heavy hammer, which delivers a blow like that of a real hammer, just at the moment of firing, and about an inch to the right of the axis of the piece, thereby tending to rotate it in that direction and to disarrange the aim. Why must the hammer be such a heavy affair, or why must there be a hammer at all to explode the cartridge? That a cartridge may be exploded as well by a less terrific blow, there is no doubt. Shotguns and army pistols have a much lighter hammer and weaker spring and yet do their work well.

There is much room for improvement upon the present rear sight of our rifles. The indistinctness of the graduations is a constant source of annoyance in skirmish firing. It is impossible to set the sight when advancing at a run.

For known distance practice where time is not a consideration, they are all right enough; but does any one suppose that men under the excitement of battle, or out of wind from advancing by rushes or double time, can or will set these indistinct sights as ordered? The graduations are so hard to see on the range that, in order to make them more distinct, our best shots often fill them with chalk or whiting for skirmish firing. For actual service we should go back to the leaf sights as the Germans have done, or else have spring notches, plain and distinctly visible, so that all the captain's command need be, "first," "second," or "third notch" or leaf. As they are at present it takes a good light and perfect eyesight to set a sight as ordered, except by guess.

The battle sight should have few and very plain graduations about which there can be no mistake. An extra leaf with finer graduations for long-distance firing, with wind gauge, etc., could, if it is needed, be placed beneath the battle sight. Let us hope that the new rifle, the trajectory of which is to be very flat, will do away with raising and lowering sights within battle range.

The rifle should also have a *third band* about six inches below the present upper band, with swivel attached, so that it could be conveniently carried over the shoulder by means of the sling. As the sling is at present attached it cannot be carried at "swing rifle" with any comfort (see Plate 19, page 43, Drill Regulations). There should also be a hollow space in the butt of the rifle and carbine in which to carry cosmoline, a brush and thong, and a greased rag. Every soldier in the field should have these articles, and they cannot be conveniently carried in the knapsack or pocket.

As weight, especially in long marches, is quite an item in the many things that go to make up the efficiency of a soldier, everything that he has to carry on his person should be lightened in every way possible; and as some maintain that no weight can be dispensed with in the rifle, it seems at least that the bayonet and scabbard might be lightened. If the bayonet, which now weighs eleven ounces, were ten inches long and in the shape of a hunting knife, it would be useful for other purposes as well and would not weigh as much, and its scabbard could be of leather, weighing but a few ounces, instead of three-fourths of a pound as the present iron one does; nor would such a bayonet and scabbard be always in the soldier's way whenever he wishes to sit down, as is the case with the present one. A bayonet ten inches long is just as deadly as one eighteen inches long.

In the matter of accouterments it would seem that the heavy brass buckles now supplied for the field belt and the leather belt could be replaced by buckles made of aluminum, a very much lighter metal. The meat can, tin cup and canteen, which the soldier has to carry on his person and which now weigh about two and three-fourths pounds, if made of aluminum would weigh less than a pound. For practical purposes and to make every possible diminution of weight in all that a soldier has to carry on his person, why should not all ornaments and all buttons on overcoats and other garments be of aluminum?

Under the head of equipments of a company I desire to call attention to company boxes, or rather to the fact that we have no such thing as company boxes, suitable for use when the company moves or for storage purposes in the barracks, furnished by the quartermaster's department. Those who were in Chicago during the opening ceremonies of the World's Fair will remember what a sight it was to see a company of regulars unload its baggage.

Necessary as such boxes are, there is no way in which they can be obtained except for a company commander to get on the good side of the post quartermaster and get him to make some sort of a box, or to buy the timber and iron for them in some way and have them made in the company by a company carpenter. The result is that company boxes are alike in no two organizations and many companies have no boxes at all, and when commands move one sees the most heterogeneous lot of baggage, in general appearance not unlike such as one finds in the storeroom of a junkshop. Why cannot the quartermaster's department make and supply each company with a suitable and properly made set of boxes, including bread and mess chests, nicely painted and labeled? These might be sent out to posts, filled with clothing or quartermaster's stores, thereby saving special freight on them.

Some of the Canadian militia are supplied with laced canvas trunks, four for each company. These trunks or valises are made of heavy duck (painted and about the size of an average company box), laced on top through eyelets with a heavy cord, and are used for carrying extra blankets or clothing.

I know all company commanders would be glad to have four or five such valises, to be used for similar purposes, or for packing tentage in when on the move, because they are very serviceable and weigh but little. As it is we generally tie our tentage in bundles with ropes, in which it becomes easily damaged and soiled, and is sure to get mixed up with the property of other companies where there are different commands moving together; and our extra blankets are packed in boxes which weigh almost as much as the blankets do.

Rations.— In the matter of rations some few suggestions, more especially useful in times of war or in field service, are offered: Each of the component parts of the ration which is used in active service should be put up in packages by the contractor, so as to be in multiples of 100 rations. For instance 100 rations of coffee is 10 lb., a bag of coffee should weigh 50 or 100 lb. net, which is coffee ration for 5 or 10 days for 100 men; 100 rations of sugar is 15 lb., 100 rations of sugar for 5 days is 75 lb., for 10 days 150 lb., and so on.

Bacon,	75 lb.	net to the package,	100 rations.
Hard bread,	50 lb.	" " "	50 "
Beans,	150 lb.	" " "	1000 "
Beans,	75 lb. (half sack)	" " "	500 "
Coffee,	100 lb.	" " "	1000 "
Sugar,	150 lb.	" " "	1000 "
Sugar,	75 lb. (half sack)	" " "	500 "
Vinegar,	10 gallons keg	" " "	1000 "
Vinegar,	20 galls., half bbl.	" " "	2000 "
Vinegar,	40 galls., bbl.	" " "	4000 "
Soap and salt,	40 lb.	" " "	1000 "
Soap and salt,	20 lb.	" " "	500 "

A sack of bacon would thus always be 100 rations; a box of bread, 50 rations; a sack of beans or sugar, 1,000 rations; a half sack of beans or sugar, 500 rations, and so forth.

The advantage of a uniform system in the weights of packages containing any of the component parts of the ration is obvious. This method of sacking and packing would be especially useful in time of war, when great quantities of these stores are to be shipped and handled.

It would do away with an immense amount of labor in weighing and reweighing every time stores change hands or are to be issued. By merely counting packages, the amounts on hand or being forwarded in cars or wagon trains could be almost always accurately stated. At such times and when it becomes suddenly necessary to forward rations by wagon train, perhaps to be loaded during the night; or when a brigade or regiment is required to draw ten days' rations on a dark night preparatory to a move early in the morning; there is great advantage in knowing the weights of all packages. No weighing would be necessary except what can be done on a small scale for the odd pounds, nor need even a pencil be used to add weights as they are loaded. By counting packages a commissary can tell accurately at any time how many rations are in any particular wagon or train.

Twenty sacks of coffee would weigh 2,000 lb. and be

20,000 rations, about a load for a wagon. Fifteen sacks or 30 half sacks of sugar would be 15,000 rations and would weigh 2,250 lb. At present, hard bread is the only part of the ration so issued. This is issued in 50 lb. boxes, or rations for 50 men for one day.

This rule of uniformity in weight should also be followed in sacking grain for animals. Sacks of corn should weigh 120 lb. or 10 days' rations for a horse; sacks of oats 60 lb., or 5 days' rations.

All proposals for army contracts for rations and forage should specify the number of pounds required to the package. The additional cost would be very small.

As shrinkage in weight is due almost altogether to the evaporation of water, no account need be taken of this in issuing the rations in unbroken packages of the kind indicated, just as at present no account of it is taken in issuing hard bread and soap. But if this be an insuperable objection, then add to each sack say 2 per cent., to make up for any shrinkage that might occur in weight between dates of purchase and issue.

In regard to the different kinds of food that go to make up the soldier's ration, there is probably but little improvement necessary. In these days of canned vegetables it would seem, however, as if tomatoes and green corn in cans should be a part of the ration. In the field there is not enough antiscorbutic in the ration as now prescribed. Potatoes and onions, being bulky and heavy and subject to being frozen, should be issued desiccated for field service. My experience with desiccated potatoes and onions, from having used them an entire winter in Colorado, is that they can hardly be told from fresh vegetables when well soaked and properly prepared. A half hour's soaking in warm water, or overnight in cold water, is all that is necessary.

There should also be issued to troops in the field or on the march, and especially when fresh beef cannot be obtained, beef extract as now manufactured in its semi-solid state. For a noonday lunch or on a long fatiguing march, a tin cup full of beef tea, either hot or cold, would be infinitely better than the everlasting coffee, especially such as a soldier gets. Extract of beef is easy to carry and easy to use and is very palatable with a hard tack soaked in it. Extract of the coffee bean, containing all the elements except the woody fiber, can now be obtained in a liquid state and also in solid shape in cakes or tablets like chocolate, each cake being enough for one or more cups of coffee. By substituting these for the green coffee in the field ration, especially in times of war, a great saving of weight would be effected. There would be no coffee burnt by the cook and the coffee mill could be left at home. Such articles of food may cost a little more than those which men now get on a campaign, but war is an expensive game at the best, and much sickness and camp dysentery could be prevented by providing more nourishing foods.

When armies are raised composed of men entirely unused to camp life and coarse foods, more men are killed in the first six months after they take the field by bacon than by bullets. It is expensive business to recruit men simply to lie in hospital awhile, and then be pensioned for the rest of their lives, in order to save money on the food supply.

Clothing.—In the matter of army clothing there has of late years been considerable improvement in some respects, but many believe there is room for more. In the matter of color of the uniform, except for the recent associations connected therewith, no one will deny that gray is better than dark blue. It cannot be seen as far and does not show dust or dirt as easily. Cadets have always worn gray, even when the Southern troops did, if that be an objection. If gray is the best color, it should be adopted for our army. We might with equal propriety never eat corn bread because the Johnnies lived principally upon that article of food during the war. Certainly blue is *not* the best color. We all know how plainly visible a marker is on the target range at any distance. One could not have a better target than a soldier dressed in a dark blue blouse. He is much more distinct than the black paper silhouettes at which we fire.

The overcoat of the enlisted men is made of excellent material, but it is not made so as to get the most warmth or protection out of the material in it. There is too much cloth around the body, if we include the cape, and not enough to protect the legs and thighs. It should be longer and have more material in the skirt. The cape should be very small, and only protect the shoulders, or better yet, there should be no cape at all, but instead a hood such as officers wear, for rain or cold weather. As now issued with a long cape, the knapsack cannot be worn unless the cape is detached, and then what shall be done with the cape but leave it at home? The overcoat should be longer and more like an ulster, just as ours is; and in order that the front skirt be not in a man's way when marching, or climb up on his knees in going against the wind, there should be a couple of buttons and button holes to button them back with, leaving the legs free. There should be two breast pockets in the overcoat outside and one side pocket at least, so that on the march a soldier may have a chance to warm his hands there and also have a place to carry a few things, such as his pipe and tobacco, or an extra box of cartridges. If outside pockets are unmilitary, as some say, why do officers have them in their overcoats? At all events it is not good sense to sacrifice recognized utility to an old fogy notion. There is too much of that in the army, and besides, an overcoat is not a full dress affair.

We need no full dress coat for a soldier. The padded dress coats they now wear are very warm, and yet they are principally worn in summer. They are uncomfortable in every way, and expensive, and as far as looks go do not come up to a well-made blouse, nor does a company look as neat in dress coats as in blouses. There is no better garment to show off a good figure such as most of our men have than a blouse. To take the place of the full dress for soldiers I would suggest the present blouse, just as it is, except with a standing collar, a few white facings for the privates and gold lace chevrons for the non-commissioned officers; then when it has been worn awhile for best, these might be removed and the blouse worn for every day, without trimmings. The American people do not take kindly to much fuss and feathers any way, and the less of these we are made to wear the more respect they will have for us.

Gorgeous uniforms may be tolerated in Europe from the peculiar conditions which exist there, but to Americans, a man bedecked in gold lace and plumes is not an object of admiration, and any person so arrayed is apt to be jeered at by the small boys on the street, and the small boys often echo the sentiments of their parents. I believe that in this country where people hate ostentatious display in its officials we should strive for utility and simplicity in army uniforms, and the sooner the better.

The presence of a regiment dressed as was the Twenty-second infantry when it was in camp on the lake front in Chicago during the riots, having been brought in from a campaign on the plains and dressed apparently for business only, had a better effect upon a mob than if the men had been dressed in finery with gold lace. In these things we copy too much after European armies. We should set the example for simplicity, utility and common sense in clothing our soldiers, and we would save much unnecessary expense and be less subject to ridicule by non-military people. "We have heard it said by those of old" that fine uniforms are beneficial in some way toward making good soldiers, and that the soldier will be more military if he wears one, but this, too, we believe to be old fogyism.

Under the present *regime* the private soldier has plenty of head gear. A well equipped soldier has a dress helmet (Prussian), forage cap (French), a cork helmet (British), a musk rat cap (Esquimaux), a slouch hat (cowboy), a brown cap which covers his entire face and neck except his eyes (Kuklux), and at the discretion of the post or company commander a straw hat, to wear in summer when off duty.

Who prescribed all these different sorts of head gear for the army? and by what authority do some *made blouses* have outside pockets and others not, some six buttons and some five?

The fact is that whatever is sent out to a post nowadays, by some quartermaster, is uniform for the soldier, and it is only by examining the annual price list issued by the quartermaster's department that we can tell what his military wardrobe should consist of. In order that an officer may be dressed as his men are, he should have all these things also, we presume, yet as there are no positive orders requiring company officers to wear what their men do—leggings, hats, fur caps, fur gauntlets or overshoes—we sometimes see commands turn out with officers wearing combinations of any of these articles or entirely without them. The supply departments apparently know what we want, and so they send it to us, and consequently we are apt to appear at any time in strange and odd looking garments, being experimented upon like models in a military shop; and are accumulating thereby an ever-increasing military wardrobe, wearing with patience anything sent to us, until the next change.

When we come to the subject of shoes for the army we feel discouraged. My own personal experience goes back only as far as 1873, but at least ever since then, the quartermaster's department has faithfully tried to manufacture or contract for a good shoe. We have had many different kinds of shoes and boots since then, but none which were at all satisfactory, and yet, strange to say, during all these years, one could step into any store in a large city, and purchase just such a shoe as a soldier would like to wear when he marches. The quartermaster's department seems to have an idea that an army shoe must be some odd shaped affair, different from anything that any one else wears, who walks or hunts, and in that respect alone have they so far succeeded in the matter of shoe production. There are many styles of excellent marching shoes manufactured in this country, shoes with soft uppers, broad toes and sole, and a low, flat heel, laced far up to prevent dust getting to the foot, just such a kind as any pedestrian would purchase, but they cannot be bought for $1.78. A good sewed shoe of the kind mentioned cannot be made for less than $3, and as soon as the quartermaster's department becomes cognizant of this fact, it may succeed in providing the army with a suitable shoe.

The cowboy slouch hat, of which I have made mention heretofore, is another instance of poor economy in buying inferior goods. This hat would be the most comfortable and useful of the present head gear for field service if it were of good shape and quality, but ours is made of cheap wool instead of felt, and it becomes so shapeless after the first rainstorm that it gives thereafter even the most exemplary soldier the appearance of having been on an extended spree.

We in the line are so entirely in the hands of our friends of the supply department in all these matters of arms, equipments, rations and clothing, that any changes or improvements brought about in any matter suggested must come through them; but as we have the opportunities, from our experience with troops, of observing defects that might escape the attention of these departments, it is to be hoped that we will not be deemed presumptuous in pointing them out.—*Jour. Mil. Serv. Inst.*

THE KIESELGUHR FIRE BRICK.

A SOMEWHAT novel brick has recently been introduced under this name as a substitute for ordinary fire bricks. The chief advantage about these bricks is their lightness, which renders them specially suited for blast furnace pipes, covering retorts, etc. They can be used for all the purposes to which an ordinary fire brick is put, as the material of which they are made, *pure* Kieselguhr, possesses chemical properties which render it as infusible as quartz. These bricks have been utilized for special purposes in chemical works, where lightness and great heat-resisting and non-conducting properties are desirable, with great success. They also give satisfactory results for retort settings at gas works.

The success of these bricks as fire bricks is now undoubtedly established, and as an indication of their lightness as compared with other fire bricks, it may be mentioned that the brick itself has a specific gravity of 0·6. A cubic yard weighs about 12 cwt., which is about a fourth of the weight of a cubic yard of Dinas bricks.

Some idea of the composition of the brick can be gathered from the following analysis of the Kieselguhr from which they are made:

Silica	83·8	per cent.
Magnesia	0·7	"
Lime	0·8	"
Alumina	1·0	"
Ferric oxide	2·1	"
Organic matter	4·5	"
Moisture and loss	7·1	"
	100·0	

This is an average analysis, and represents the average composition of Kieselguhr.

MANUFACTURE OF SODA ALUM.

UNLIKE the solution of potash or ammonia alum, a boiling solution of soda alum of a density of about 60° Twaddell's hydrometer, or 1·3 specific gravity, gives on cooling scarcely any or no crystals; and one which is much above this density, instead of yielding on cooling a crop of well defined crystals, from which the impure "mother liquor" may readily be drained out, resolves itself into an opaque, viscid or cheesy magma.

It has been proposed to overcome these difficulties by running the hot, strong solution of soda alum, under prescribed conditions, into a cold saturated solution of soda alum, and by that means to obtain good crystals free from the cheesy magma above mentioned. It has been found, however, in actual working, that the quantity of cold saturated solution of soda alum required for this purpose is relatively so large—viz., about three times the quantity of the hot solution—as to make it difficult by ordinary means to so regulate the temperature of the whole as to obtain the crop of crystals, and thus the process is rendered unremunerative.

A magma which requires no treatment with cold solution, but which on being stirred or turned over will resolve itself into soda alum crystals and mother liquor, is produced as follows: A hot, highly concentrated solution of soda alum is prepared in the usual way from ordinary sulphate of alumina and sulphate of soda, or from alumino-ferric and sulphate of soda, and this is mixed with a smaller proportion, generally one-half the quantity, of cold saturated solution of soda alum to yield on cooling a magma not too stiff to be freely stirred or turned over.

It is practically more economical to use alumino-ferric than a purer sulphate of alumina—a solution of alumino-ferric of strength not exceeding 60° Twaddell, or 1·3 specific gravity; and in this is dissolved the requisite quantity of ordinary commercial salt cake containing the usual percentage of sulphate of soda, the proportions used being about five parts, by weight, of alumino-ferric cake to one part, by weight, of salt cake.

The operation is conducted in the lead-lined steam dissolving box used by alum manufacturers. While steam is being blown into this box a stream of the alumino-ferric solution is run through the box and at the same time the salt cake is shoveled till the whole of it has been dissolved by the alumino-ferric solution. The solution thus obtained is run into a tightly covered lead-lined tank, in which it is allowed to stand until the suspended impurities have been settled out. This takes about twenty hours. The clear liquid is then run off into a lead-lined evaporator fitted with a coil of lead pipes containing high pressure steam, and by means of this coil the solution is boiled down until it attains a strength of about 90° Twaddell, or 1·45 specific gravity. This boiling liquid is then run into a cold saturated solution of soda alum in the proportion of about two parts, by volume, of the hot solution into about one part, by volume, of the cold liquid, taking care to thoroughly mix the two liquids by means of a suitable stirrer. The mixed liquid is then run into a lead-lined cooler of such a depth as will allow the magma that is to be produced to be easily turned over by means of a wooden shovel. Then, by means of a wooden rake, mixed liquids are agitated and cooled until the magma has formed, and the magma is then turned over at intervals by means of a wooden shovel, until it has been brought down to ordinary atmospheric temperature and till it has been transformed into good crystals of soda alum. The agitation of the mixed liquids necessarily tends to cool them more quickly, and thus to hasten the formation of the magma; but if the mixed liquids are allowed to cool without agitation, the magma produced may then be turned over, as above described, until it is transformed into good crystals. By these means the magma is converted within a comparatively short time into good soda alum crystals, from which the impure mother liquor may be readily drained out by any well-known means or may be separated by a centrifugal machine. This obtains a crop of soda alum crystals equal to or greater than the weight of the alumino-ferric cake employed to produce it. From the resultant mother liquor such proportion as will, together with the small portion of iron removed by the alum itself, withdraw all or practically all the iron that was introduced by the hot concentrated solution is removed, and the remainder of the mother liquor, which is the "cold saturated solution" already referred to, is reserved for mixing with a new increment of hot concentrated solution, as already described. The proportion of mother liquor withdrawn is utilized either (*a*) for conversion into potash alum or ammonia alum by well known means, the alumina being readily crystallized out of the solution as potash alum or ammonia alum on the addition of the proper potash or ammonia salts, or (*b*) is used either in the liquid form or in the form of a cake for the purification of sewage or other impure waters or for any purpose for which impure aluminous compounds may be employed.—*Chem. Tr. Jour.*

THE Bordeaux mixture has been used with success in experiments by the Department of Agriculture to rid fruit trees of lichens which adhere to the bark of the trunk and limbs. The mixture was applied with a whitewash brush and the lichens at once turned yellow, and within three weeks were all dead. Later experiments showed that equally effective results could be had with the ordinary spraying machine.

WOVEN WIRE AND SEGREGATION.*

By BRYAN CORCORAN.

WHEN kindly honored by the invitation of your council to read a paper, I thought I would try and systematize some facts about sieving, and give such explanations as to render the tables I have made out of practical service. The explanations are rather simple for such an audience; some are necessary for demonstrating other points than those I touch to-day, but they all tend to make the subject complete and allow of clearer definitions, and I hope they may lead to the better understanding of the more complicated processes.

From any large gathering or collection may be selected a number of individuals on account of some special characteristic which they possess. In this way may be separated the large from the small, long from short, fat from thin, round from angular, rough from smooth, etc. Some may be set apart from their irregularities, while others are segregated because they are left out of all calculations and belong to no recognized class.

Segregation is the whole aim of the miller. It is segregation that brings us together to-day. Segregating processes are going on in everything in all manner of ways and everywhere. All machines in a mill are segregators or some arrangement for helping them.

I soon found that to make a logical story it was necessary for the explanation of sifting to be preceded by the consideration of sieves, and this again had to give place first to the material of which they are made, to arrive at anything like clearness.

Wicker work and perforated skins can doubtless claim priority in matter of antiquity, but the most important, and that with which I begin, is woven wire.

Woven Wire.—The inch is the standard of measure. I take No. 10 as my example, and therefore divide the inch into ten lines (Fig. 1), the square inch into 100

FIG. 1.

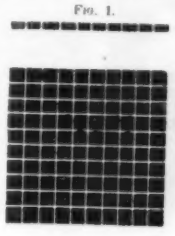


FIG. 2.

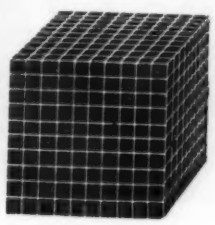


FIG. 3.

squares (Fig. 2), and the cubic inch into 1,000 cubes (Fig. 3).

Figs. 1 and 2 have reference to mesh, while Fig. 3 more particularly refers to the material to be sifted or dealt with. For want of a better term I shall call one of the little cubes of which Fig. 3 is built up my unit. The lines in the above diagrams may be understood to have "length without breadth," but woven material is made of wire or threads having substance or thickness that occupy space, and I wish to show how this materially affects all calculations, and how a slight difference in their thickness alters the size of the units; in other words, when the wire is thin the units are large, and when the wire is thick the units are small. The amount of work in dealing with the material is also altered.

Mesh.—There is some uncertainty about the exact way of measuring the mesh. Webster's Dictionary, referring to nets, says it is the space inclosed by the string, or the string that incloses the space, which does not help us much. Woven wire should be measured from "center to center." It is generally only in the coarser holes that any doubt can exist as to the mode of measurement, or where hand made wire work is paid for by the piece, when instead of the actual 10 spaces and 10 wires in each inch, only 10 spaces and 9½ wires are often reckoned; and this probably arises from the fact that it needs 11 wires to make 10 spaces.

Tenth of an inch mesh may mean the size of the hole "in the clear," in which case the number to the inch is regulated by the thickness of the wire, but No. 10, or 10 hole, or 10 mesh, cannot well be measured otherwise than from "center to center," like the pitch in gear wheels, which is not determined by the thickness of the teeth, and where it is only necessary to continue counting round the whole circumference to discover that there are the same number of teeth as spaces.

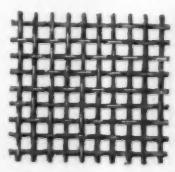


FIG. 4.

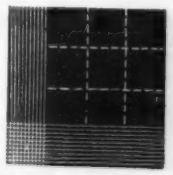


FIG. 5.

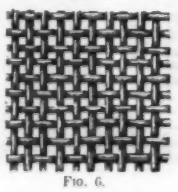


FIG. 6.

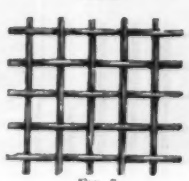


FIG. 7.

The safest way to count the mesh is to commence on the center of a wire (warp) and continue until the end of any inch again coincides with the center of a wire, and divide the number counted by the number of inches. Take 4¼ mesh as an example. At the end of the first inch the count is found to be over four mesh, and yet it is difficult to determine how much, whereas at the end of the fourth inch it comes exactly to 17, or 4¼ pitch, or the correct count.

Weaving.—Suppose 0·025 be the thickness of the wire in our sample (Fig. 7). Ten such wires (warps) touching each other make ¼ in., leaving the other ¾ in. open space (Fig. 5). The shoots gathered together in the same manner gives the dead surface $\frac{7}{16}$ of the square in., of which $\frac{1}{16}$ is the crossing or overlapping of the wires, leaving $\frac{9}{16}$ of space to be divided into the 100 holes. In Fig. 5 the vertical lines on the left side of the illustration represent the warp, the horizontal lines at the bottom the shoot, and the dotted lines only serve to indicate quarters of the inch. The No. 10 in my first table, owing to the wire being thinner, would divide the square inch in a similar way into twenty-five parts, nine only of which would be dead surface.

In the case of No. 10 strong rice wire (Fig. 6), such as is used in rice mills, the dead surface is nearly three-quarters of the whole (see Table 2). A foreigner generally uses thin wire for economy's sake, but the reason he gives is that it sifts more freely, which, of course, is perfectly true. An Englishman usually prefers strong work. It is a common experience to be asked to weave wire of a greater thickness than the size of the hole, forgetting that it is as impossible to do this as it is to put more than 12 in. in a foot, or 20 cwt. to a ton, for the wires that keep the cross wires from coming together are bent, and therefore occupy even more space than their thickness, and it requires a specially good quality of metal to stand being knocked up to the theoretical limit.

Fig. 7 is 5-mesh, Fig. 8 is the same mesh of stouter wire and Fig. 9 is section of the latter.

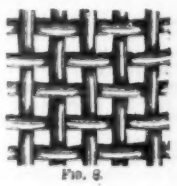


FIG. 8.

FIG. 9.

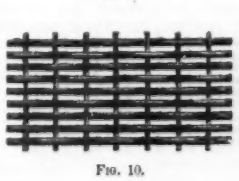


FIG. 10.

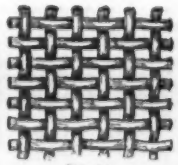


FIG. 11.

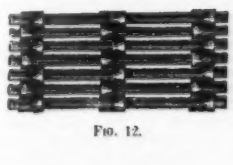


FIG. 12.

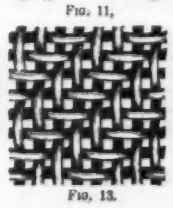


FIG. 13.

Of course there are ways of getting over these difficulties by making the mesh long instead of square (different count one way to what it is the other), warp and shoot of different thicknesses, or straight shoot with flat warp, etc. (Figs. 10, 11, and 12), but it does not immediately concern my subject.

My late father exhibited No. 150, or 22,500 square holes, brass wire in the first Great Exhibition of 1851, and No. 160 × 180, or 28,800 square holes, in the International Exhibition of 1862, both made on the old premises, 36 Mark Lane. I believe that this is the finest straightforward wire weaving that has been accomplished, and that anything finer than 120 will be found to be twilled, and this is done as fine as No. 200.

Twilling (see Fig. 13, and section, Fig. 14) does not produce a clear passage through the cloth, and is not well suited for sifting, as the holes are not all open alike, but it enables a thicker wire to be woven with less power, and inferior metal can be utilized. In this way also, springy material, such as horse hair, may be made into sieve bottoms of a finer mesh than is possible in ordinary weaving. It also enables almost a solid surface to be produced, as in the case of hair seating for upholstery work, where the thread warp is hidden and the horse hair brought into view, forming a smooth face.

Silk Gauze.—Wire is kinked by the process of weaving, which is sufficient to keep the meshes from shifting, unless the wire is very thin. For preserving the mesh in the best silk, there are two warps, which are twisted together between each shoot (see Fig. 15), otherwise the threads might be drawn together after the manner shown in Fig. 5; this gives a somewhat hexagonal shaped hole, but in my calculations I have taken the liberty of averaging it, and reckon a square hole, and with warp and shoot of parallel and equal thickness. In fine meshes there is an alternate twisted warp (see Fig. 16), in still finer only an occasional one, and in the very finest it has to be omitted altogether.

I am indebted to some friends for their kind assistance in measuring the thickness of fine threads, etc., by the microscope.

Effect of Dead Surface.—Referring back to the cube (Fig. 3), and if instead of being divided by lines without thickness a cubic inch of material be sawn up and each saw cut be 0·025 in. wide, which is the thickness of the wire in Fig. 4, the 1,000 units will occupy only a little over two-fifths of the cubic inch (Fig. 17), and

FIG. 14.

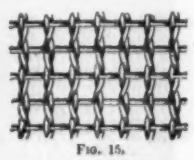


FIG. 15.

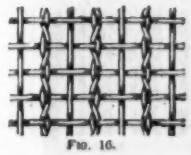


FIG. 16.

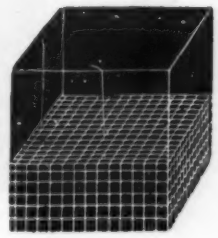


FIG. 17.

those of the rice wire not much more than one-seventh. To avoid as far as possible unnecessary repetition, I shall speak of the unit that just fits into any hole as respectively the unit of No. 10 sieve wire, No. 10 rice wire, No. 150 wire, No. 6 silk, etc.

The 1,000 No. 10 sieve wire units placed one layer deep, forming, as it were, a tesselated pavement, occupy 5¾ in., although still requiring 10 in. of wire for each hole to be filled with a unit.

The No. 10 rice wire units closed up together only cover 2¾ in., but again still require 10 superficial inches for each unit to occupy a hole.

The 1,000 units of the No. 10 sieve wire average 5¾ in. deep over a square inch (Fig. 17), and those of the rice wire only 2¾ in. deep.

It requires 2,379 sieve wire and 7,111 rice wire units respectively to make a cubic inch, a very great increase over 1,000, the nominal cube number without thickness of wire (see Fig. 3).

Passage Through the Meshes.—Suppose the units in a cubic inch be piled up in columns over the holes in a square inch of the wire, the height will be 23¾ in sieve wire and 71 in rice wire. Again, suppose the meshes or holes to be all closed so that no unit could pass through, and that some "action" opened the holes momentarily, allowing only one unit to get through each mesh before it closed again, it will be seen that this would take away the bottom layer of units resting on the meshes, and that the number of "actions" to pass the whole quantity would be the same as the number of units making the height contained in these imaginary columns.

Cube and Sphere Units.—Unfortunately the cubic unit cannot easily pass through a mesh that it just fills, although a globe or sphere of the same diameter may do so, and I have therefore also calculated for spherical units.

The difficulty in calculating this "piling of shot" may interest some, for I found that although each row contains the same number of balls, the rows fit into the interstices of their neighbors, and so occupy less space, and each layer drops into the recesses in the layer below; in other words, the number in width is greater than in the length, and in the depth again greater than in the width, thereby greatly increasing the total quantity contained. (See Fig. 18, where L represents the length, W the width, and H the height or depth.) I give elevation and plan of a pile of spheres, and between these a plan of the two top layers, showing how the top one sits in the cavity of the three be-

EXTRACT FROM TABLES OF RELATIVE SIFTING CAPACITY, AND PROPORTION OF DIFFERENT SIZED PARTICLES PASSING THROUGH DIFFERENT MESHES OF

TABLE I.—*Woven Wire.*

	Mesh, Holes to		Cube Number.	Pitch and Hole of Wire.	Size of Wire.		In clear Mesh or Hole without Wire.	Number of Units in a Cubic Inch.		Sifting Actions for One Inch Deep.	
	Inch.	Square Inch.			B. W. G.	Diameter.		Cubes.	Spheres.	Cubes.	Spheres.
No.	No.			in.	No.	in.	in.				
	4	16	64	0·2500	20	0·0360	0·2140	102·0374	144·3022	6·3773	8·5077
	5	25	125	0·2000	21	0·0320	0·1680	210·8999	298·2934	8·4360	11·9304
	8	64	512	0·1250	24	0·0220	0·1030	915·1314	1294·2307	14·2989	20·2223
	10	100	1,000	0·1000	25	0·0200	0·0800	1953·1250	2762·2098	19·5312	27·6220
	20	400	4,000	0·0500	28½	0·0142	0·0358	21794·4927	30822·6854	54·4862	77·0567
	50	2,500	125,000	0·0200	35	0·0084	0·0116	640657·7304	906027·6557	256·2628	355·1067
	150	22,500	3,375,000	0·0066	45	0·0028	0·0038	18284212·0294	257 297·1643	809·9650	1145·4654
	200	40,000	8,000,000	0·0050	47	0·0020	0·0030	37037035·9185	52378510·5954	925·9256	1309·4627

TABLE II.—*Stout Woven Wire.*

	5	25	125	0·2000	14	0·0800	0·1200	578·6067	818·4013	23·1478	32·7361
	10	100	1,000	0·1000		0·0250	0·0750	2370·3626	3352·2140	23·7035	33·5221
	10	100	1,000	0·1000	18	0·0480	0·0520	7112·0060	10058·0545	71·1200	100·5805

TABLE III.—*Silk Gauze.*

5	64	4,096	262,144	0·0156	..	0·0035	0·0121	564473·3543	798290·2823	137·8108	194·8972
10	106	11,236	1,191,016	0·0094	..	0·0060	0·0064	3812697·2056	5394798·2220	399·3287	480·1751
15	148	21,904	3,241,792	0·0068	..	0·0020	0·0048	9042541·0008	12787036·6581	417·3777	583·3467

TABLE IV.—*Stout Silk Grit Gauze.*

	26	676	17,576	0·0384	..	0·0010	0·0374	19115·5489	27033·5413	28·2774	42·4474
	70	4,900	343,000	0·0142	..	0·0004	0·0138	380507·5819	538115·8947	77·6546	109·8105

* Paper read before the National Association of British and Irish Millers' Convention held at Liverpool, June 13, 1893.—*Engineering.*

neath it. The rest of the diagrams, I think, need no explanation.

Measurement of Fractions.—I have spoken of decimal parts as though the units were cut up into pieces to make their number fit into an inch. The division is only theoretical to facilitate greater accuracy in calculation, for the units overlap the divisions of the inch.

Some to whom I have shown the puzzle of piling of shot made the remark that piling a definite quantity could not be calculated, as it depended on their relative size as to how many could be got into a box of particular dimensions, for the rows and layers do not commence and terminate at the same place, so I venture to point out that this is not my problem. I simply give a figure that may be multiplied to give the correct number in a screen of given dimensions or a vessel of any size.

Surface of Sieve.—The holes in perforated flat sheets have an even top edge, which is easily closed by any large material resting on the surface. Woven wire presents a succession of knuckles all over, without any flat surface for the material to rest on. Perforations, again, can be plugged so tightly by a slightly tapered rod fitted into them that water cannot pass. This is not possible in woven wire; a square rod may be fitted into the hole and the wires may press it as closely on all sides, but owing to the roundness of the wire there is a crooked passage through each corner that cannot be stopped.

A perforated hole, especially in thick plate, with its parallel sides the whole depth, is much more easily blocked than a woven mesh, for the wire presents the smallest surface at the smallest part of the hole, and even this is bent, and is not horizontal at any point.

Accuracy.—Exact truth is difficult to attain in anything, and the best scientific instruments often only enable the amount of error to be discovered and estimated.

In my tables I have, of course, reckoned a square mesh and wire of even thickness, etc., and with fairly good work slight discrepancies will not make themselves felt in the ordinary way, but the demand for greater exactness in details becomes more pressing as competition increases.

In some businesses woven wire is now used as a standard gauge, usually the square number; so I venture to point out some of the difficulties.

The warp is the right count, but it may fit loosely in the reed in the loom; the shoot is seldom knocked up

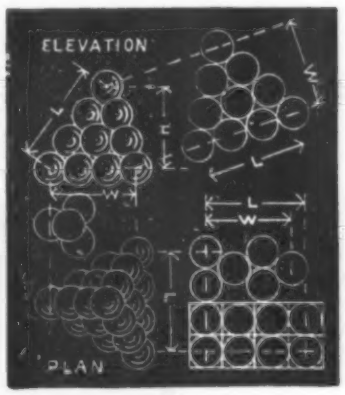


FIG. 13.

by the weaver to the nominal count; it is generally about 5 per cent. coarser, and may be irregular, with lines of holes larger or smaller. The wire may not be round, nor all of the same gauge either in warp or shoot.

In making a long length of wire, the hole through which it is drawn wears so that the wire is a shade smaller in diameter at one end than at the other. The temper again of the metal may be uneven, allowing of unequal bend at different parts. Notwithstanding all this, the average is good enough for most purposes.

Relative Capacity of Meshes.—A good miller avoids fine meshes as far as possible, especially in dealing with a large bulk of material, for by their use the process of sifting is lengthened, it is made more expensive, more power is expended, the material being treated is more rubbed, more machinery is required, the wear and tear is increased, and the renewal is more costly.

The supposed necessity for fine numbers is often the result of previous bad work, and is generally resorted to as a cure for evils that need not exist. By my third table it will be seen that No. 5 (64 mesh) silk passes twice as much as No. 10 (106 mesh), and nearly three times as much as No. 15 (148 mesh), and these proportions are greatly increased when much of the material is fine. Moreover, there are means of obtaining fine results through coarse meshes.

Separation.—In dealing with material of mixed sizes —some normal, some large, and some small—over woven wire of such a mesh as just to allow the normal to pass through, the small will pour such holes as are not blocked or partially closed by the larger pieces lying over the holes, and in their hurry these smaller will also tend to obstruct many of the normal that might otherwise have dropped through.

It becomes evident that in a mixture, such as, for instance, one measure each of peas, wheat, mustard, clover, and dodder seeds, it is economical to take the large off first. In this diagram the proportion necessary for each sieve is fairly shown by the length of the different lines representing the wires:

Wire No. 4	Peas pass over.	
" " 8	Wheat	"
" " 10	Mustard	"
" " 20	Clover	"
	Dodder passes through.	

If the same mixture be fed on to a long screen, with the fine mesh at the head and the coarse at the tail in regular succession, the fine mesh not only has to bear the whole bulk passing over it, but needs to be of greater extent in consequence, and this inconvenience, although diminished at each mesh, continues all the way along the screen.

No. 20	10	8	4	Peas
Dodder.	Clover.	Mustard.	Wheat.	

I have not altered the length of each number of the wires from the diagram above, but the screen would have to be longer or some dodder will pass with the clover, some clover with the mustard, some mustard with the wheat, etc.

Sifting.—To take from a quantity of sand 10 per cent. that will not pass through No. 50 mesh I reckon it will need by my first table about 230 sieving actions to deal with a depth of 1 in., viz., 256, less 26 for the 10 per cent. of the coarse.

Put the sand into a No. 50 hand sieve, and shake the sieve until the separation is complete. It will be found that at first only the finest sand passes through; gradually it comes coarser as the process continues, till at last the largest particles that can possibly pass go through, leaving the 10 per cent. of too large in the sieve. Therefore, on a screen of any considerable length it is necessary to have a succession of several meshes, coarse at the head and fine at the tail, to produce a result of average degree of fineness.

We have seen that the coarse particles impede the passage of the normal that could otherwise pass through the meshes; that the fine crowd the surface of the sieve and obstruct them. Again, the normal may come the wrong way about, or get piled on the wires like an arch, and neither go through themselves nor allow others to pass; they may also come in contact with the wire more than once without passing through a mesh, and if their shape is irregular, they may try several times before they are eventually worried through.

All these circumstances tend to upset one's calculations, but I think they prove that the depth of the material on the sieve should be reduced as far as possible. For instance, No. 20, by my table, has in round numbers 28 cubic units over the whole surface of the wire, and requires 56 actions to make an inch deep of them pass through; but suppose we take a depth of only a quarter of an inch or seven deep over the whole surface, which requires only 14 actions to pass all through, the trouble is greatly decreased, and I think in this way my calculations may be of service in regulating the right quantity of feed passing to successive machines clothed with different meshes of wire or silk.

Conclusion.—The speed even of water passing through a sieve is impeded by the wires, and a mass of material whose particles are not too large to pass through the meshes will rest on the surface of the wire till some action moves it. As an example, turn a pepper caster topsy-turvey and a little pepper is obtained by the action, but no more passes unless the caster is again shaken.

Work cannot be accomplished without labor. In the case of the hand sieve it is the man's arm, and in machinery the driving strap, that imparts the power. The advantages of the latter are the more even speed and greater regularity of motion. Many motions can be given by dexterity to a hand sieve with as many different sifting results, and with machinery the number may be increased almost indefinitely.

I believe the relative value in sifting actions of these motions and combinations may be calculated for the different machines, but it would take time, and I have already made this paper too long.

In conclusion, I beg to suggest that "the bringing together of like things" may be accomplished by many means. I have endeavored to restrict my observations to-day to the use of meshes, but there are different methods of working even these; there are also different forces that can be utilized, and these methods and forces in combination form an endless variety of means for overcoming most difficulties.

NEW MUSICAL INSTRUMENTS.

THE number of harmonic effects that are truly agreeable to the ear are limited, and there is even reason for astonishment that it is so large, seeing that all music is based upon the combination of the same elements—the seven notes of the gamut.

The first composers of music worked upon an unexplored mine, while those of our day, under the penalty of plagiarism (and, to tell the truth, all is found, or at least indicated, in Seb. Bach), are constrained for want of original melody difficult to find, to make research anew either through skillful harmonic combinations or through the introduction into orchestras of instruments giving a new sonorousness.

Of these two resources, the first is beginning to become exhausted. Since Palestrina, who was the first to employ them, the dissonant accords have been thoroughly studied, and include little that is unknown. Moreover, too many dissonant accords, or too many too bold dissonances insufficiently prepared or resolved are not very satisfactory to the ear, which quickly tires of them. As has been facetiously written: If a piece of music formed solely of consonant accords is comparable to a salad with oil without vinegar, a piece with a judicious combination of consonant and dissonant accords to a salad with oil and vinegar, a piece based solely upon artificial harmony is like Russian salad—abuse must not be made of it.

It is, therefore, necessary to salute with pleasure the creation by Mr. Fontaine Besson of some new instruments, the pedal clarionet and the cornophone, which fill certain wants of the orchestra by increasing the number of its voices and by adding, according to the expression of our great Gounod, new colors to the palette of the composer of music.

The pedal clarionet or counter-bass clarionet (Fig. 1) is an instrument with the grave octave of the ordinary bass clarionet. It is in *si* flat, and descends to the *la* natural, and even to the *la* flat. Thanks to this new instrument, the family of clarionets embraces more than six octaves. The pedal clarionet possesses the wind-reed mouthpiece of the clarionet and the recurved bell of the saxophone. It is provided with a system of plates, assuring a more perfect stopping than the rings ordinarily employed. The fingering is the same as in the thirteen-key clarionets, and it is especially through improvements in the tubes and the extended mechanism that are obtained the following interesting results: Softness of *timbre* wholly unexpected in the *piano*, great power in the *forte* and mellowness and fullness in the medium register. In the notes at the extreme grave, as might be expected, the beats are marked and the accuracy is not irreproachable. In solo the pedal clarionet lends itself very well to the interpretation of certain religious or dramatic *morceaux*. In the orchestra it will serve usefully to double the string counter-basses, whose effects they

FIG. 1.—PEDAL CLARIONET.

will emphasize, even in the pizzicati, which it imitates in a surprising manner.

The cornophone (Fig. 2) furnishes a new *timbre*, a sonorousness intermediate between that of brass instruments and that of wooden ones. Its special voice, less commonplace than that of the cornet or saxhorn, and somewhat recalling that of the bugle, is due to the conical form of the sonorous body and of the mouthpiece branch similar to that of the horns. The cornophone will replace, or at least double, the harmony horn, which is so difficult to play. It will execute the parts written by Wagner in his tetrology for the famous tuben. At the chorister's desk it will dethrone the ophicleide and the antique serpent.

The cornophone lends itself to chamber music, like the tenor violin or the horn, but it is especially in military music that it will be of great value in playing the parts of the horn in place of the tenor saxhorn, whose sonorousness so slightly approaches that of the horn. The family of cornophones embraces: (1) The soprano cornophone in *si* flat, in unison with the cornet; (2) the alto cornophone in *mi* flat, *fa* and *mi* flat, *mi* flat and *re* natural; (3) the tenor cornophone in *si* flat, *ut* and *si* flat, *ut*, *si* natural and *si* flat; (4) tuba cornophones of four pistons in *si* flat, *ut* and *si* flat, *ut*, *si* natural, *si* flat; and (5) the counter-bass cornophone in *mi* flat, *fa* and *mi* flat.—*La Nature.*

FIG. 2.—CORNOPHONE.

CROCODILES AS SCAVENGERS.—The Bombay officer of health protests against the decision of that corporation to adopt means for the utter destruction of the crocodiles. He says they are the best and only scavengers possible of the water reservoirs in which they dwell; that they clear away all decomposing animal and vegetable matter, all obnoxious substances which there are no human means of removing.

THE MOTION OF LIQUIDS STUDIED THROUGH CHRONO-PHOTOGRAPHY.

AN experimental study of locomotion in water necessitates the possibility of determining both the motions of the animal that is swimming and those that it communicates to the liquid in which it is moving. In a preceding article I have shown that chrono-photography permits of following the phases of a fish's motion. I am going to show on the present occasion the conditions in which this method lends itself to expressing the motions that take place in the liquid itself.

Mathematicians have submitted the waves produced on water and the currents and eddies that are formed in its depths to analysis, but they have always regretted that they had no other experimental basis than the very uncertain data furnished by simple observation. The play of light on the surface of water and the agitation of small bodies held in suspension in the liquid are phenomena too fugitive to allow our eyes to appreciate them exactly. This is why I have attempted to fix their characters by chrono-photography. The arrangement that I have employed will be able to serve physicists as well as physiologists. It is represented in Figs. 1 and 2. Here is in what it consists: Water is put into an elliptical vessel whose sides for a portion of their length are rectilinear and formed of glass. It is in this transparent part that the motions of the liquid, rendered visible as will be described, are seized by photography. A dark field of black velvet is placed behind the transparent part of the vessel. In front, opaque curtains arranged in a sort of hollow pyramid extend to the objective of the chrono-photograph and prevent the external light from illuminating the liquid. The latter is traversed from bottom to top by the solar light reflected by an inclined mirror placed at the level of the floor.

If the water is perfectly limpid, it will be traversed by the solar light without any of it being sent in the direction of the photographic apparatus, save in that part of the surface that wets the glass wall situated at the side of the apparatus. At this place, in fact, capillarity forms a concave meniscus that extends all along the wall. The solar light that has traversed the water experiences a total reflection under this meniscus. So there is observed upon the ground glass of the photographic apparatus a very brilliant and very fine line that marks the level of the water, and, displacing itself therewith, shows upon the photographs all the undulations of the surface. When it is desired, likewise, to catch the motions that take place in the interior of the liquid, they are rendered visible by means of small brilliant bodies in suspension in the water, and that the solar light brightly illuminates. To this effect we melt, in suitable proportions, wax which is not so dense as water and resin whose density is greater. Then, with plastic material, we make a large number of small balls that we silver by the process in vogue in pharmacies. These brilliant pearls must be slightly denser than soft water, so that if they are immersed therein, they may reach the bottom slowly. It suffices then to add gradually to the vessel a certain quantity of salt water in order that the brilliant pearls may remain suspended in the mixture and in indifferent equilibrium.

Finally, a centimetric rule drawn upon paper is glued to the glass side above the level of the liquid (Fig. 2). This rule, which will be reproduced in the images, will serve as a scale for measuring the amplitude of the photographed motions.

With this arrangement, it is possible to perform a large number of experiments on the motion of liquids. I shall present a few of these under the form of photograms.

Change of the Profile of Liquids in Waves.—The brilliant line that marks the level of the water takes on, when the liquid is agitated, inflections that recall those of vibrating strings. The centers and the nodes, that is to say, the crests and the hollows, now occupy fixed points as in choppings and now displace themselves with variable velocities as in waves and swells.

At A, Fig. 3, is represented the motion, *in situ*, of a chopping wave. This motion was obtained by plunging into the water, at equal and properly regulated intervals of time, a cylinder that produces regular oscillations in the liquid. These rhythmed impulsions must be produced in the part of the vessel opposite that where the motion is studied.

The objective of the apparatus being opened permanently, the brilliant line of the level of the water has left a trace of its passage at all the places that it has traversed, but with a greater intensity at the points where its velocity was less. Thus, in the vicinity of the nodes and dead points of its oscillation, that is to say, at the crest and at the depression where the velocity, before changing sign, passes through a minimum. If it is desired to know better the changes of velocity presented by the profile of the wave at the different phases of a simple oscillation, it is necessary to have recourse to chrono-photography, that is to say, to admit light during very short instants and at regular intervals of time. We then obtain (Fig. 3, B) the successive positions of the level of the liquid. These positions are shown by more widely spaced curves in the center of the oscillation and closer together in the vicinity of the crests and depressions.

Finally, if we change the cadency of the motion communicated to the liquid, by accelerating it gradually, we fall into other periods of chopping motion in which the waves are shorter, like those of C in Fig. 3. In all cases the profile of the wave that passes through the crests and depressions has the form that hydraulicians have assigned to it—that of a trochoid.

The animate shifting waves, billows and swells show upon the chrono-photographic images the velocity of their carriage, as well as their changes of form of amplitude.

The line, D (Fig. 3), represents through chrono-photography a wave produced in the following manner: The cylinder that serves to set the water in motion is immersed in the vessel at the right extremity of the glass wall, at a point invisible to the observer. After the agitation of the water has ceased, the cylinder is raised and then suddenly immersed again. The series of images seen at D, in the figure, corresponds to the first instants of the phenomenon.

It is at first a series of progressive lowerings of the level of the water in measure as the cylinder emerges, then a sudden intumescence at the moment at which the cylinder is immersed anew. This intumescence makes its way toward the left in gradually diminishing in height. Smaller waves interfere with the principal wave and accompany it in its travel. As the number of images was fourteen per second, we shall know the velocity of the wave at every instant by measuring with the metric scale the distance traveled by its crest during each fourteenth of a second, say about 0·16 m., which corresponds to a velocity of 2·24 m. per second.

The shifting waves give chrono-photography incomplete profiles. The posterior side is the best marked, and sometimes the only one visible upon the images.

Internal Motions of the Liquid in Waves.—There

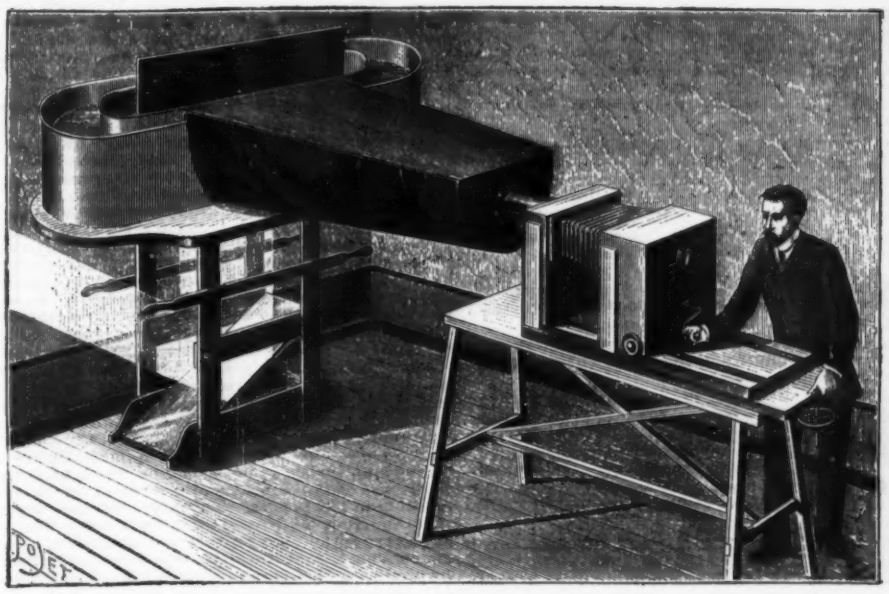


FIG. 1.—ARRANGEMENT FOR THE CHRONO-PHOTOGRAPHIC STUDY OF THE MOTIONS THAT TAKE PLACE IN AGITATED LIQUIDS.

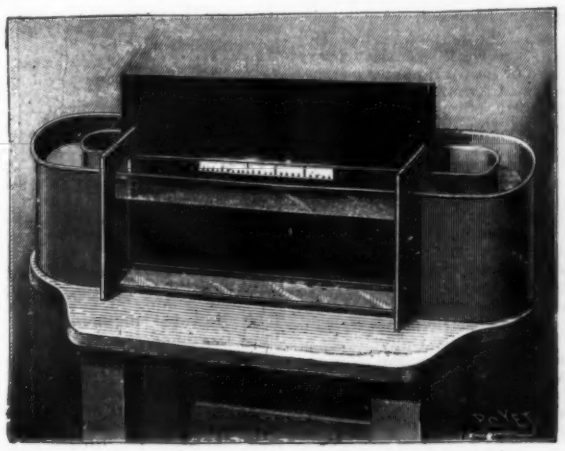


FIG. 2.—DETAILS OF THE VESSELS IN WHICH THE MOTIONS OF THE LIQUID ARE RENDERED VISIBLE.

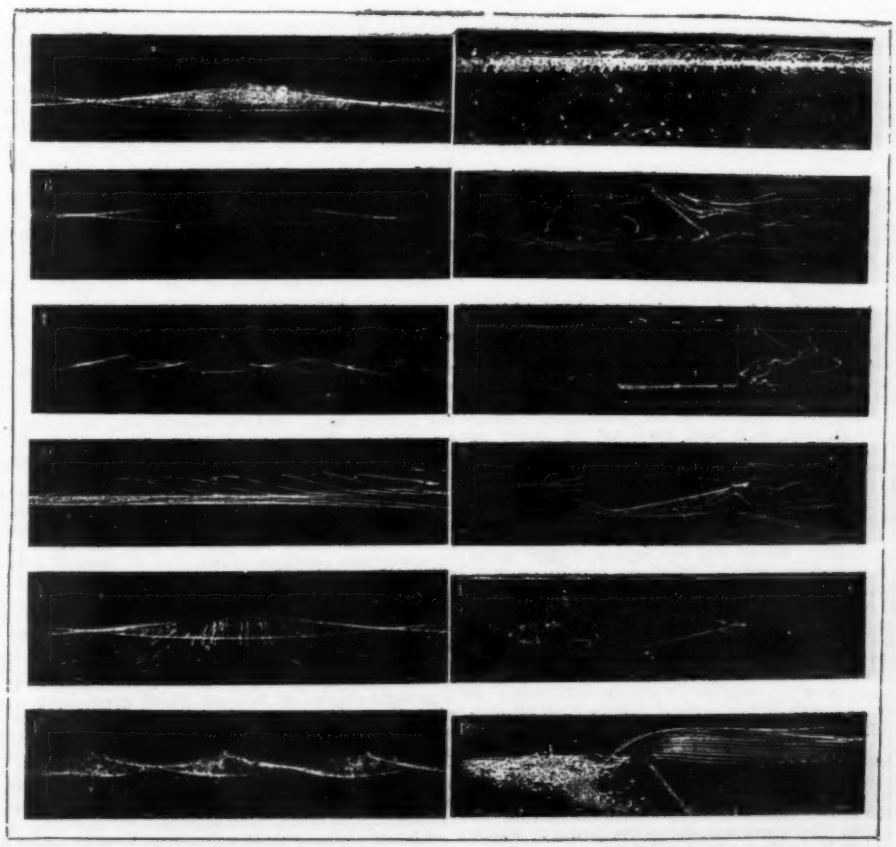


FIG. 3.—REPRODUCTION OF CHRONO-PHOTOGRAPHS OF THE MOTIONS OF LIQUIDS.

are distributed through the vessel the brilliant pearls spoken of above. If we then reproduce the motions of a chopping sea or of waves, we obtain upon the photograms the trajectories of these pearls in the different parts of the wave, that is to say, the motions that the molecules of the liquid itself undergo at such points.

At F in Fig. 3 we recognize by its profile a simple chopping wave. In the interior of this wave the molecules oscillate vertically opposite the centers horizontally to the nodes, obliquely in the intermediate positions. In order to better follow the *ensemble* of these internal motions, let us produce (F) a wave of shorter period. We then see how the trajectories of the molecules arrange themselves according to the curves whose centers are at the nodes. These experiments confirm the results given by the analytical studies of our confrere Boussinesq.

In progressive waves, the internal motion of the molecules is different. Thus G is produced by the abrupt immersion of the cylinder in the vessel. The wave moved from right to left; the objective was opened permanently.

The molecules of the surface describe ellipses in a plane parallel with the direction of the carriage of the wave. In the deep layers of the liquid, the curve followed by the molecules is less and less pronounced. At the bottom of the vessel their trajectory ends by reducing itself to a nearly straight line.

When the cylinder is given a to and fro motion as in D, Fig. 3, the molecules describe closed curves on the surface of the liquid.

Currents and Eddies.—The annular form of the vessel permits of producing continuous currents therein, by means of a small helix immersed at a point more or less distant from that at which the motion is observed. The brilliant pearls participating in the motion of the liquid itself permit of determining the trajectory and the velocity of the liquid molecules in the different regions of the current.

In order to obtain H (Fig. 3), there was placed upon the passage of the current an obstacle formed of a plate of glass inclined at an angle of about 45 degrees. This plate, held by friction between the two glass sides, presents its edge only to the objective of the chrono-photograph.

The photographic plate was exposed for three seconds. The frequency of the images was 42 per second. The current moved from right to left.

If we consider at first only the trajectories of the different liquid streamlets, we shall see that these reach the obstacle with more or less oblique directions, and that, according to the law of Aranzini, there occurs a division of these near the lower edge of the inclined plane. Back of the obstacle, the liquid streamlets form capricious eddies.

As to the velocity of the current at every point, that is deduced from the spacing of the images of the pearls. These latter, sometimes confounded in a continuous trajectory, express a great length of current. At other times separated from each other, they permit of measuring, according to the metrical scale, the distance traversed in $\frac{1}{42}$ of a second, that is to say, the absolute velocity of the current.

With this arrangement it is easy to measure the influence exerted upon the division of the liquid streamlets by the inclination of the plane and the velocity of the current. It is also possible to determine how the liquid streamlets behave according to the obstacles with which they meet.

Thus, in the case represented in Fig. 1 the obstacle was formed by a box in the shape of a rectangular parallelopipedon immersed in the vessel, of which it occupied the entire width. The upper and lower faces of this box were of glass, in order to allow of the passage of the light and to illuminate the pearls that passed above the box. The current moved from left to right.

In front of the vertical side of the box the liquid streamlets divide, and, as soon as they begin to inflect, their velocity accelerates. They pass rapidly along the edges of the box and form eddies behind.

At K and L (Fig. 3) are shown how the current behaves on meeting a pisciform body; that is to say, a solid whose section would be a sort of spindle unequally pointed at the two extremities.

At K the current met the pisciform body by its obtuse side. The fluid veins follow the walls and escape in the rear in presenting little deviation. But, if we reverse the direction of the current so that the liquid reaches the pisciform body by its sharpest extremity, the liquid, after exceeding the center, forms very pronounced eddies. (I, Fig. 3.)

The intensity of the eddies which constitute a loss of live power may be considered a criterion of the resistances met with by bodies immersed in a current. Now, it will be seen that the form of fishes, whose anterior extremity is generally obtuse and the posterior very tapering, is perfectly adapted to the facility of their motions in water. For, according to the majority of authors, the conditions of the resistance of fluids are reversible, that is to say, they are the same, at equal velocity, for immovable bodies immersed in a current and for these same bodies moving in an immovable liquid.

When the liquid is thrust with violence against an obstacle immersed near its surface, it rises and falls in a cascade on the other side of the obstacle. This fugitive phenomenon, which the eye cannot follow in its details, is translated with all its phases by chrono-photography. Fig. M shows, according to the changes of the level of the water, the successive phases of the intumescence of the liquid that reaches the obstacle, while the brilliant pearls translate the motions of the molecules in the deep layers of the vessel. This brief enumeration of the applications of chrono-photography to the analysis of the motion of liquids will suffice to show the resources of this method, which I am at present applying to the study of the locomotion of aquatic animals.

Physicists also will perhaps be able to have recourse to this method for verifying certain points of the theory of waves and currents, and even for studying the action of the different sorts of propellers from the motions that they communicate to the liquid in which they move.—*E. J. Marey, in La Nature.*

LECTURE ON DECORATION.*

By Mr. LOUIS SOLDER.

THE object of my address to my young friends here to-night is simply to place before you a few practical hints from a practical man, which may be of use to you in your future career.

In learning your trade, always remember that you don't want to let your trade become master over you, but that you want to become master over your trade. It is only the man who has a thorough grasp of everything connected with his trade who can do full justice to his work, to himself and those who employ him. Therefore your aim should be to prepare yourself for all those emergencies, great and small, which constantly occur in our business, no matter what position you may occupy. Our trade has no set or narrow limits; the conditions under which our work is done vary constantly, and no painter should be content if he has simply learned how to wield a broad or round brush. Do not think that I wish to speak disparagingly of such an accomplishment. Indeed, there is a good deal of art even in that, and I know from personal observation that it is not every man bearing the name of painter who can use these tools with *intelligence*, and, if he cannot do that, he is not master of his craft. He who throws his whole soul into his work, be it only the whitewashing of a passage, he it is who makes the superior as well as the quicker workman.

My remarks to-night, however, are more intended for those whose ambition it may be to become decorators. Now, what is a decorator? Decoration is such a wide term that it compasses almost everything that goes to make the house beautiful, but I use the word here in a narrower sense, that is, as it applies to painting—decorative painting. And under this appellation we may place all the work, from the humble tinting of a ceiling and cornice to the elaborate fresco paintings in the House of Parliament and elsewhere, or Raphael's painting in the Loggia. The same principle applies to them all: they all depend upon local conditions, such as light, position and structural surroundings, and I am convinced that the artist who perpetuates his fame by producing these grand compositions on a great scale of magnitude would find it by no means an impediment if he happened to have had in his earlier years the training of a house painter. So you young men may rest assured that should some of you in time find yourselves, by your talent or energy, on the highest step of the decorative art ladder, you will not have altogether wasted your time by learning all you can during your apprenticeship.

As regards ornamental decoration, which concerns us more directly, I may tell you plainly that, in my opinion, it is *absolutely necessary* that you should be a good plain painter (I mean one of the intelligent kind) before you should try to become a decorator, or at least that you should learn the one along with the other. Certainly, there are some who profess to or can do nothing but put on a stencil or run a line; very nicely, no doubt, some of them do it. There are others more advanced in their art, and some at the top of it, who confine themselves to producing designs for the others to execute, and no doubt there is work produced in this way sometimes of the highest artistic excellence, and which should be a joy, if not for ever, at least for a long time after the bill has been paid. That, however, depends greatly upon the foundation! They have had to employ the plain painter for that. If they happen to get the right man who knows his business (and a great deal more than he is supposed to know), then all is well. But if they get the wrong man, what will be the result? Therefore, a decorator, in order to be able to exercise a full control over his work from the beginning, ought to have a sound knowledge of plain painting, of the materials employed therein and their stability, as well as their physical effect upon the colors of the decoration. I can assure you a ground coat with too much terebine, or even too much oil, in it has more than once destroyed all the more delicate effects of the finished decoration, and I can say for myself I would not allow any man to coat a wall which I am to decorate unless I know that he understands his business well.

Therefore, as the architect who designs a mansion in most artistic style must still know all about brick, stone and wood to be able to consider and to secure the stability of his work, just as much must the decorator know the nature of the materials and processes connected with the production of his work, or half of his labor will be in vain. Some years ago I knew of an artist-decorator, a gentleman of the highest standing as a designer, and at least a passable colorist, making futile attempts to produce on a staircase wall a pale yet full golden or amber tint, certainly one of the most difficult colors to produce in "flat." He got the painter to make up a color and try it on the wall, which, by the way, had already received a ground coat, rather oily, of a yellow made of ocher, umber and white. "Yes, this color is just what I want; go right ahead with it and I will call back in a day or two." But alas! when he came back where was his golden color? There was a dull yellow instead, nothing like the luster which the pattern had. Did the painter alter the color? He swore "No, sir, not at all," and the man spoke the truth. But what the artist did not know, and what in this case the painter did not seem to know either, was the fact that the oiliness of the ground combined with the dullness of its color had absorbed all the luster of the finishing coat. "Well, the walls must have another coat." Some of the flat was left over and they made up some more, and, to make sure to have it brighter this time, put in more chrome yellow than they had used before, and then the wall was coated again. But this time it turned out far too bright a yellow and with a nasty, unequal gloss. You see, the painter had put a good drop of varnish into his flat, to bind it as he thought, and this, with the addition of the fatty chrome, had prevented the color from going down to that right degree of flatness which gives such a soft tone to an otherwise bright color, especially in the case of all yellows. Had the decorator been a practical man, he would have instructed the painter to use some chrome in turpentine, if the raw sienna, which was also used, would make the stuff too flat; and if the painter had thoroughly understood his business, he would have used raw oil instead of varnish to "bind" his flat, thereby giving it time to flatten gradually. I wish to impress you with the importance of becoming familiar with this and other parts of your trade as house painters, and if you have spent your time well in learning, you will become a valuable assistance to the ablest decorators, even if you cannot all reach such a position yourself.

There is another species of the genus decorator, that is the amateur decorator of both sexes. Of the lady amateurs, or I should say of some of them, our courtesy forbids us to say harsh things. "With all their faults we love them still." There are, in the ranks of amateurs, some very able ladies and gentlemen, from whom even the experienced professional decorator can get a hint or an idea now and then; but there is a certain kind of gentleman amateur, whom we now encounter all over the world, who is rather troublesome. He has got hold of a certain amount of superficial knowledge, such as may be gained by the perusal of some of the many handy books on decorative art, and he quickly comes to the conclusion that the craftsman who does the work knows less about it than the client. No wonder! In some of these books which I have come across the very first thing necessary seemed to be to condemn the orthodox house painter with all his belongings as the very incarnation of ignorance in decorative art matters. Then the author of the book generally proceeds to detail how very easily the reader, with his inborn good taste, which, of course, nature has denied the poor house painter, how very easily he can make his home "beautiful" by means of patent paints, enamels, gold size and gilding. Unfortunately, in practice, the paint won't dry, the gold size won't gild, the gold won't come off the artist's fingers, the enamel *will* persist in running down the corners, and the varnished floors keep every one captive who ventures upon them.

But by and by your art amateur begins to profit by his experience. Practice, he finds, does not agree with him. He takes to theory only, and rides the decorative high art horse. He discovers that certain papers can be had from certain places only, the farther away the better, though perhaps the painter next door has the same pattern in his window. He has made the profound discovery that ivory white looks well with almost any paper and furnishings, and that terra-cotta forms an agreeable harmony with peacock blue. Does the *painter* know these secrets of chromatic combinations as well? Oh, dear no; how should he? One gets these things from books only, and, of course, he doesn't read these books. (Here I must draw your attention to the advisability of making yourself familiar with the current fashionable literature on decorative art matters, so that you may be able to meet your amateur customers on a common ground.) But to return to the gentleman aforementioned; he has frequently, not to say invariably, more leisure than the professional decorator, who has to keep his pot boiling for wife and bairns may be, and therefore the former may sometimes be able to think out a new and original idea, and if he would confine himself to indicating his notions to the latter the result might be satisfactory, but if he will insist upon prescribing the whole *modus operandi* to the painter decorator, the whole thing will most likely end in disaster. But here my young friends may ask, "Should we always expect to follow our own minds, to get our own ways and expect the customer to submit to what we may consider our superior judgment?" Not by any means. I can assure you, in the intercourse with intelligent people of taste outside your trade, you may learn quite as much with regard to it as within your own circle. Allow me to quote Burns' verse here: "O wad some power the giftie gie us, to see ourselves as ithers see us!" The moral is obvious. You will find in the course of your profession the sensible customer is always prepared to follow the advice you give, provided it is honest (which he will feel instinctively), and that you have been able to convince him that you understand your work well. But he may have got in his mind a certain effect, a certain feeling or scheme of color, perhaps contrary to your notions, which he would like to see produced, and it is just this individual taste or inclination of a cultured mind which is of the greatest value to the decorator. For, to enter into another man's ideas, which may even for a moment stagger you as being absurd to your practical mind, you have to step outside your own self, and self-abnegation is always a wholesome exercise.

You may be able to supplement your client's ideas by your own practical knowledge, and by conquering seeming difficulties, arrive at a good and perhaps novel result, gain the satisfaction and esteem of your patron or employer, and get a substantial bit of experience for yourself into the bargain. Of course, all this requires patience, but that is a virtue which you can never cultivate too much, and by considering other ideas besides your own, you are continually stimulated to new efforts, and thereby prevented from getting into a certain rut, into which your own inclinations and prejudices might lead you unknown to yourself. It is for the satisfaction of the public we work, and as long as we do so without sacrificing our individuality entirely, or without abandoning the true principles of our art, we may safely allow ourselves to rejoice in the appreciation of the public.

Sometimes it happens that a customer says, perhaps: "I want my dining room done nicely; I leave it entirely in your hands; I know you will make a good job of it." After considerable reflection you adopt, say, an olive green for the walls, with a glow of orange in it, his pictures consisting mostly of portraits, with some landscapes, and the golden hue of the olive enters into a harmonious blending with the gold frames while forming an excellent neutral background for the pictures.

Using the olive as the basis of your color scheme, you introduce some browns, golden yellows, creams and a little soft greenish blue into the decoration of the cornice and ceiling. The latter you enrich with some firm, suitable ornamentation, of course keeping in view a certain repose in the arrangement, and then you are prepared to recommend a dull blue for curtains and chairs, with perhaps some brown and very dull gold color. Your customer has taken a holiday in the Mediterranean, and returns in the autumn, when you are just putting on the last touches, for true painters' work is always in hand up to the very last moment

* Delivered at Heriot-Watt College, Edinburgh, before the students of the painting and decorating class.

available, no matter how long a time has been granted. Your genial customer views your work with expressions of satisfaction, but after all cannot refrain from saying: "I think I could have liked the color of the walls a little warmer; I saw some rooms in Naples done in a terra cotta; they looked so very comfortable." Fortunately you have the furnishings to fall back upon yet, and you advise now your patron to get a rich dull red for his chairs, etc., with some amber, olive and blue in the trimmings. When the room has been furnished accordingly, your man is quite pleased with the whole effect, even remarks with a good-natured smile, "Fools and bairns shouldn't see a thing half done;" but I am not quite sure but what he may still have an occasional hankering after his beloved terra cotta walls. Now, with skillful treatment, the one color might have done as well as the other, had you only known your customer's fancy for it. Different people are differently impressed by certain colors, and it is advisable before commencing your work to inform yourself of the little peculiarities of taste and perception of color of those people who, after all, have to *live* in the house you decorate. With public buildings the case is different; there you can only be guided by your own taste and the purposes of the edifices.

Now we must consider the more practical side of our subject. In decoration you have two elements to consider—*form* and *color*—the latter perhaps the most important to the decorator. In nature, color occupies first place. Color without form occurs frequently: for example, the cloudless azure sky, the color of water when we are diving, or the red which presents itself when we close our eyes in the sun. On the other hand, we cannot conceive form without the presence of color, bearing in mind that black and white are colors in this sense. Even allowing white not to be a color, but light pure and simple, it can only exist in the absence of form; even in the case of freshly-fallen snow, wherever there is the slightest undulation visible to our eyes, it manifests itself through the presence of shadow, tinged with color. It appears to me it is color that makes form visible. We may argue that this is not so, since a photograph still shows all details of an object, but we must consider the lights and shades in a photo are simply *representations* of colored effects, and the true ideal would be a photograph in natural colors, not necessarily in pigments, and the recent inventions and researches in that direction seem to have brought the realization within our reach. In decoration you have often occasion to produce color without form, such as laying walls and ceilings in with different tints, and that might even be done without regarding the lines of the cornice as form, by painting the lower walls, say a brown, and working gradually lighter till it terminates in the ceiling in a cream color. I mention this latter point more as an argument than as an incentive to practice, though I recollect a case where I carried out the same principle with considerable success. It was a hall, or rather saloon, in the Rococo style, and the order was reversed here, beginning with white below, finishing with a brilliant airy blue on the ceiling. The walls were broken up with scrolls and mouldings and with mirrors in rich frames, which were done in silver and pale gold; the richly carved furniture was gilt with coverings in blue satin damask. There was no cornice, but instead of it the space between walls and ceiling was covered with fantastic scroll work, and here the white of the walls was gradually softened into the blue of the ceiling, which formed an oval dome. The whole effect was very striking and pleasing, and was heightened by the brliliant coloring of huge Dresden vases, which were placed in front of the mirrors, and even by the occasional appearance of a footman in gorgeous red and silver livery, with white powdered hair.

In ornamentation pure and simple, color is as important as form. Even in the case of self-color, some consideration is required regarding the different hues of the same color. In painting a picture, form becomes more important, as by it the disposition of color (which here also makes form visible) is guided, and the artist's aim is to give a tone representation of an object *outside* the picture. In decorative painting, no absolute illusion is intended, and where such is attempted, the true principles of decoration are disregarded. And this should be good encouragement to you, that even those whom nature has not endowed with a talent for drawing or designing, may yet aspire to become artists in the matter of color alone.

In the study of color, and the laws of harmony and contrast, you will meet with some difficulty on account of the difference between the older and the more modern theories on the subject. The fact is, a successful combination of colors depends quite as much upon taste, natural or acquired, as upon theory. Indeed, for a time *fashion* seems to create certain prejudices in our minds with regard to certain combinations. Some years ago, when low tones were so much in vogue, almost to the exclusion of positive colors, a red of any pretense to brightness would have been quite startling to most eyes, even when combined with gray, whereas at the present day we seem to take no objection to the bright reds which we meet everywhere in large masses in the costumes of fashionable ladies in our promenades.

The older theory is, that there are three fundamental or primary colors, red, yellow and blue, which by mixture produce the secondaries, orange, green and purple.

These again by mixture produce the tertiaries, and so on.

This is quite correct as regards *pigments*, but pigments are not *colors*, they are merely the means to produce color.

Color in the strictest sense is demonstrated to us by the spectrum, as you may try for yourself by means of a glass prism and some sunshine. Modern science has found that the fundamental colors of this spectrum are quite different, and although there are still different theories, it may be said, as representing the opinion of most modern scientists, that the primaries are red, green and purple blue, which, by combination, form yellow, bright blue and carmine red. These facts have been demonstrated in a darkened room by letting rays of differently colored light overlap one another. The old theory has the advantage that it is a very good guide for the mixing of pigments, and is, therefore, of great value to the student of decoration; but I would advise you to consider the new theory very carefully indeed. I also would recommend you to secure good examples of harmonious coloring of acknowledged value and to analyze them; that is, find out the reason why those colors look so well together, always keeping in mind that not only *contrast* but also *analogy* are factors in the production of harmony, and remember the effects being got by using light against dark, and *vice versa*.

I show you a color circle which contains the colors of the spectrum in twelve divisions, which will help you in finding the proper contrasts, according to modern theory, by selecting the colors opposite each other. But you must consider the colors mentioned more as names, merely indicating a *class*, each of which comprises the thousands of tints of its kind which come before our eyes.* And then study nature in its various moods. The colors are never alike. Don't look upon trees merely as green trees, but try to find out how it is that in the spring time the lovely green of the tender leaves of the young beeches looks so charming against a clump of dark firs and the blue sky above.

As regards form, your endeavor in the first line should be to acquire the art of drawing with power of expression, so valuable afterward in designing ornament, but, with all due deference to those who think differently, I am of opinion this cannot be done by simply copying a given drawing while being placed before the student. The retentive faculties of the brain with regard to form should be developed, and the best way to accomplish this is, in my experience, to look carefully at a given object, not necessarily a drawing, impress it upon your mind as well as you can, then turn round and try to bring it to paper without seeing it again. When finished, compare your drawing with the original, notice where you have erred, not only in the proportions, but also in the characteristic details, which give the expression to the form. Then repeat the process.

If you practice this system, you will in time become as able to draw what you have seen as you may be able to write down a story you have heard. When my time has permitted me, I have instructed several pupils successfully after this method, and, as the child must have a name, I have called it the mnemonic method of drawing, as it depends so much upon memory, and it will enable you to preserve almost unconsciously in your mind any characteristic points you find in your study of ornament, and to incorporate them, may be years later on, in your designs, without resorting in the least to copyism. As a conclusion, let me advise you to go frequently to the museums, where you have such a grand opportunity of studying the arts of the whole world, without walking half a mile. Truly Mahomet does not now require to come to the mountain; the mountain has come to Mahomet, if he will only take the trouble to look at it.

* Thus, terrra cotta instead of orange against peacock blue.

PHYSICAL DEVELOPMENT.

THE substitution of bromide of silver without free nitrate of silver, and the consequent development of the image from the haloid itself for iodide, or bromo-iodide of silver with free silver nitrate as the sensitive material, along with its accompaniment of development of the latent image, not from the haloid, but from the extraneous silver nitrate, was undoubtedly the especial point of change when about twenty-five years ago the wet collodion process was gradually displaced by the dry plate process.

In the wet collodion process, as well as in daguerreotype, the silver deposit which constituted the developed image was not the product of a chemical reaction as is the case in modern photography by the use of alkaline developers, but originated by a peculiar physical property of the latent image, called photographic attraction. The developing agent—in the wet collodion process the free silver and in daguerreotype the mercury vapor—formed a compound with the reduction product and not with the unaltered haloid, without altering the chemical constitution of the former.

But, even in one of the modern photographic processes, the development of faintly printed gelatino-chloride printing-out paper, this old method of physical or molecular development plays a part. In this process, as well as in the collodio-iodide process, the sensitive film itself contains the soluble silver salt, which in contact with the exposed silver haloid is reduced by the developer. It may, however, be equally well added to the developer, especially if the silver salt of the sensitive film has been exhausted, as, for instance, in the process of intensifying collodio-iodide plates with silver. If any other suitable sensitizer is added to the sensitive film, as in the case of the iodide of silver dry process, the silver nitrate needs to be employed only in the developer.

It is intended by the following lines to draw the attention of the readers to a number of interesting applications of physical development, which, after very careful and extensive experiments, have been described of late by Herr R. Ed. Liesegang, in the *Photographische Archiv*.

1. *The Employment of Gallate of Silver in the Process of Developing Gelatino-chloride Printing-out Paper.*—In developing gelatino-chloride printing-out paper the excessive silver nitrate can be removed from the film by washing, when a mixture of the developer, which may eventually be acidified, with the former can be employed. Upon this observation the following method, described by Herr Liesegang, is based: If faintly exposed aristotype paper is freed from the excessive silver nitrate, and from other soluble compounds by washing in several changes of water, the image printed on it will develop in a concentrated aqueous solution of gallic acid to which a slight quantity of silver nitrate has been added, equally as well as on paper of the same kind which is developed without washing in plain gallic acid. While, however, in the case of the latter method the prints are reddish-brown before fixing, the washed prints will become intensely black by development in the gallate of silver solution. Over the older method, with plain gallic acid, this new one has the advantage that the deposit formed in the developing solution is considerably slighter. Mixtures of slightly acidified hydroquinone, pyrogallic acid, and of other organic developers with silver nitrate will act in a like manner.

2. *Acid Developers for Gelatino-bromide.*—Though in the gelatino-bromide dry process the chemical developing method has been exclusively used hitherto, the exposed galatino-bromide film may also be treated with a physical developer, if either a mixture of silver nitrate with a developer, which may eventually be acidified, is used, or if the plate is treated at first with silver nitrate, and then, without washing previously, with the developer. If a normally exposed gelatino-bromide plate is placed in a mixture of—

Hydroquinone (2 per cent. alcoholic solution)	5 c. c.
Formic acid	5 "
Water	50 "
Silver nitrate (5 per cent. solution)	5 "

a faint yellowish brown image will be obtained after eighty minutes. The developing solution remains perfectly clear. To obtain negatives of sufficient density it will be necessary to expose the plates from three to four times longer than those to be treated with a chemical developer. If in the above formula the acid is omitted, a reduction of the silver salt of the liquid soon takes place.

As mentioned above, a similar result may be obtained if the plate is at first placed in the five per cent. silver nitrate solution, and then, without washing, in the developer. In the case of taking a one-half per cent. hydroquinone solution as the latter, a brownish red image will appear after about half a minute, but afterward a metallic powder is precipitated, which, however, does not in the least adhere to the film of the plate. If acetate of soda is added to the hydroquinone solution, red fog will be produced. Silver nitrate mixed with metol very soon gives an olive brown image, while, if mixed with para-amidophenol, a yellowish brown image is produced, development being, however, slower. Gallic acid with silver nitrate does not at all develop, and with amidol at once red staining of the film is produced, together with a considerable precipitate in the liquid.

3. *Developing the Plates after Fixing.*—If a gelatino-bromide film which has been exposed to light is fixed, the sub-bromide of silver is very likely decomposed to bromide and metallic silver; but, in a normally exposed gelatine film, the contents of metallic silver are so slight that, after fixing, not the least darkening at the exposed parts will be visible. With nascent silver the molecules may, however, be rendered considerably larger, and the image becomes then visible.

If a gelatino-bromide plate which has been normally exposed in the camera is placed in a solution of hypo-sulphite of soda and, after fixing and well washing, treated at first with a ten per cent. solution of silver nitrate, then, without washing, with a developer consisting of hydroquinone and sodium acetate, a blue to bluish-violet image of slight intensity will be developed in the latter solution. The process after fixing may be carried on at daylight. Para-amidophenol, metol, or pyrogallic acid, may be substituted for the hydroquinone developer, or silver nitrate and hydroquinone may be mixed to a single bath if the latter be slightly acidified.

4. *Intensifying Negatives by Acid Development.*—If a sensitive film which has been exposed in the camera is treated with nascent silver, the latter is precipitated not only on the exposed silver haloid but also on finely divided metallic silver in absence of halogen silver. For this reason it will be possible to intensify a gelatine negative with a physical developer by separate treatment with silver nitrate and gallic acid, or hydroquinone, etc. The separate employment of silver nitrate and developer has the advantage over a mixture of the two, that in the case of the former substances may be added by which the keeping qualities of the developer are improved, for instance, sodium sulphite, and also substances by which the process is accelerated, for instance, sodium acetate. The following method has been used by Herr Liesegang.

The gelatine negative is very thoroughly washed and then placed in a five to ten per cent. silver nitrate solution. After a few minutes it is transferred without washing previously, in a diluted mixture of hydroquinone with sodium acetate, known as "aristogen:"

Hydroquinone (7 per cent. alcoholic solution)	4 c. c.
Sodium acetate (15 per cent. solution)	8 "
Water	60 "

and allowed to remain until it has acquired the desired density. It is well to place it finally in a solution of hypo. Other organic developers, in plain solutions or mixed with sodium acetate, may be substituted for the above hydroquinone developer. The intensification which may be obtained by this method is said not to be as considerable as with bromide of copper and silver nitrate.

5. *Intensifying Fixed Prints.*—According to the same principle as described *sub* 4, also fixed prints on various printing-out papers may be intensified after fixing by physical development. It makes no difference whether they have been toned or not; but it is, of course, necessary to wash them previously very thoroughly, since the least trace of hypo in the film causes yellow fog. The following experiment has been made by Herr Liesegang.

A finished print on aristotype paper was placed in an aqueous solution of hydroquinone, citric acid, and silver nitrates. The proportions of these substances are of no importance; however, a sufficient quantity of acid should be present, to prevent the reaction between the hydroquinone and the silver salt. At first no intensification of the print took place, on account of the fact that no precipitate of silver was produced in the liquid; but, as soon as a few drops of ammonia were added, so as to render the bath just neutral, a slight precipitate of silver was formed, and, at the same time intensification of the image took place. If the latter was not sufficient, a few drops more of ammonia were added. In this way the prints may be strengthened to any degree. For hydroquinone all the other silver intensifiers may be substituted. It is necessary that previously to the above treatment the prints, especially those on gelatine emulsion papers, should be well soaked in water, in order to prevent the silver deposit adhering to the film. In adding the liquid ammonia, care should be taken that it does not drop directly on the print, because it would otherwise produce yellow spots.

6. *The Application of Physical Development to Various Other Surfaces.*—From the experiment described *sub* 5, it will be seen that not only the silver molecules have the property to attract the nascent silver of the developing liquid, for in the case of a toned and fixed print, which therefore contains no more silver haloid, the gold has the same function as the silver. In like manner, in a freshly prepared mixture of silver nitrate with a suitable developer a purely physical intensification will take place—

(*a*.) Of finished chloride of silver positives in which gold, platinum, osmium, iridium, and other precious metals have been substituted for silver.

(*b*.) Of finished platinotype prints, carbon prints, Woodburytypes, of prints obtained by the powder process, and of similar prints, provided that no greasy substance has been employed in combination with the pigment, as in collotypes, letterpress prints, etc.

(*c*.) On glass, celluloid, ebonite, and on several other substances the silver is deposited, if they have previously been freed from the gas or water atmosphere condensed on them.

7. *Intensifying Finished Platinotypes.* — As mentioned above, *sub* 6 *b*, finished platinum prints may be successfully intensified by the application of physical development. The print, after being wetted with water, is placed in a mixture of—

Aristogen (see above, *sub* 4).....	10 parts.
Citric acid (2 per cent. solution)....	5 "
Water.....	150 "

to which, just before use, ten parts of a five per cent. nitrate solution have been added. After a few minutes finely divided metallic silver will be precipitated in the liquid, which, however, does not alter the qualities of the bath. The platinotype will very soon gain in density, and at the same time it turns intensely brownish-red, the whites remaining perfectly clear. The precipitate of the bath will adhere to the paper only in cases where the print has not previously been moistened with water. Afterward the print is treated either with hypo or with any combined toning and fixing bath. In fixing, the brownish-red tone of the print is preserved, though it will be reduced to some degree. With the toning and fixing bath the color of platinum is nearly obtained. Instead of aristogen, para-amidophenol, pyrogallic acid, metol, and other developers may be employed, if they are previously rather strongly acidified. With pyrogallic acid the black silver modification will be obtained in place of the brownish-red one.

8. *Silvering Glass.*—By aid of a quite freshly prepared, still perfectly clear mixture of slightly acidified pyrogallic acid, or of para-amidophenol, aristogen, etc., with silver nitrate the silvering of glass is a matter of great simplicity, provided that the surface has been previously freed from the adhering gas or water atmosphere by rubbing it vigorously with alcohol or ether. The glass surface will then be covered in a few minutes with a thin layer of tightly adhering silver. Should the thickness of layer be not sufficient, pyrogallic acid, or para-amidophenol, aristogen, etc., respectively, and then silver nitrate solution should be added alternatively. The experiment will be still more successful if the glass surface is at first poured over with the concentrated alcoholic aristogen solution, as it is sold by the manufacturers, and then, after the excessive liquid has been allowed to drain, placed in a diluted aqueous solution of silver nitrate. For the aristogen strong alcoholic solutions of other developers may be employed. The silver deposit is produced within a few minutes.

The glass may be equally well silvered if it is at first moistened with an alcoholic solution of silver nitrate, and then placed in a diluted developer; for instance, in aristogen 1 part, water 12 parts. The operation, as a rule, must be repeated in order to obtain a sufficiently intensive deposit.

In conclusion, it may be mentioned that Herr R. Ed. Liesegang gives the following explanation with regard to the action of the physical developers: Soon after the pyrogallic acid, or the para-amidophenol, metol, etc., has been mixed with the silver nitrate, the silver is suspended in the liquid in the finest state of division. The result is not a solution as it is generally understood, but a kind of emulsion. The portion of the liquid which incloses the single particles will, however, not be able to perfectly separate the silver molecules, the power of the latter for uniting themselves being greater than the adherence with the liquid atmosphere. Consequently, the silver particles unite to form larger particles.—*Hermann Schnauss, Br. Jour.*

A NEW PHOTOMETER.

IN the library of the Royal Institution Sir David Salomons, Bart., recently exhibited a new portable photometer, all the metal work in which is of aluminum for the sake of lightness. The *Engineer* says: It is furnished with an aluminum tripod stand, but the photometer is lifted from the tripod when it is used. Fig. 1 is a perspective view of the instrument. On the right is a lamp with its tube for carrying a standard candle, also a chimney and screening tube set in gimbals, the whole connected by an arm with one tube of a binocular arrangement in which is the optical part of the appliance. The tube of the binocular nearest the candle has a reflecting prism upon it, the blackened back of which is represented in the cut. At the nearest end of the tube to the left is an opal screen. The long link embracing this tube and connected with the other one gives an automatic adjustment to the reflecting prism and candle arm.

FIG. 1

In each of the tubes two Nicol prisms are mounted, arranged as usual, but instead of the analyzer being revolved, the polarizer is capable of being turned. In use the light under test is made to fall upon the opal screen at the end of one tube, while a standard light, reflected by the prism, is viewed through the other tube. The opal screen is simply for focusing purposes, and can then be removed. When using the instrument, the polarizer, which faces the brighter light, is turned until the two lights appear to be equal, the positions of the two polarizers are then read off by means of two scales on the instrument, and the distances of the two sources of light being known, the relative intensity of the two lights is ascertained by calculation.

Fig. 2 shows the arrangement of the binocular portion of the photometer diagrammatically.

The photometer packs into a sling case barely larger than those used for field glasses, and Sir David Salomons says that some of the advantages derived from this instrument may be stated as follows: "Very powerful arc lights may easily be compared with one another or with a standard source of light. It may be used for measuring various sources of light, such as daylight out of doors with light in a room, and for the estimating of photographic exposures. That the instrument is exceedingly convenient, compact, portable and easy to use need scarcely be stated. It may also

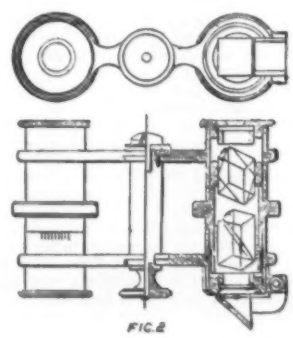


FIG. 2

be employed for rapidly comparing the lights in one or more places far apart, which is frequently a great convenience. Two points alone might be urged against the principle. The first is that Nicol prisms are not, as a rule, sufficiently accurate for very close measurements. However, to make these prisms quite accurate, or at any rate sufficiently so for this purpose, is no difficult matter, as may easily be proved by taking a number of Nicol prisms at random and testing them. Secondly, errors are introduced due to internal reflections, as well as reflections which take place at the surfaces of the prisms. These losses occur for the Nicols in both tubes, and when the losses in each tube are deducted from one another for any positions of the Nicols, the difference will be found to be so small as to affect, to an inappreciable extent, the result."

THE BATHS OF ISCHIA, OF VOLTAGGIO AND OF CASCIANA.

By BENJAMIN D. HOWARD, M.D., F.R.C.S. Edin.

LARGE as is the number of English-speaking residents in Italy, most of those I have met seem to be unfamiliar with the resources within easy reach of its principal cities for passing a cool summer. Still larger appears to be the number of them unfamiliar with the excellent mineral baths in Italy of almost every variety and temperature suitable to the various invalids requiring them. Some of these, I need not say, had high reputation in classic times, which in certain instances has continued and in others has declined. My recent experience and observation in connection with the baths of Ischia, of Voltaggio and of Casciana were in the order I mention them. The time spent at Ischia was short, at Voltaggio it was longer, and at Casciana the longest, and my remarks upon them, their administration and surroundings, I make of different lengths in the same proportion. In no instance do I intend to do more than to give items from personal observation, which may supplement statistics to be found in cyclopædias and which may be of practical use to such persons as may be, or may become, inclined to visit one or other of the baths mentioned.

The Baths of Ischia.—These baths are at Casamiciola, at the farthest landing place of that island and one to which a steamboat goes from Naples every afternoon in a little over two hours. This place is very attractive to lovers of the picturesque and is full of tragic interest, two houses out of every three being in ruins exactly as they were ten minutes after the famous earthquake which a few years ago turned the principal hotel, while a grand ball was in progress, into a mixed mass of disjointed masonry and crushed corpses. As all the houses there were of large stonework and the majority of the inhabitants were in bed, about 5,000 of them were crushed to death and never saw the light of the next day, which was the Sabbath. There are a number of new small hotels now. The bathing establishment is in a little valley, which is unfortunately about a mile inland, where the living accommodations are not commendable. The mineral water is so hot that a cold water tap is always placed side by side with the mineral spring tap to enable one to moderate the mineral water to a bearable or agreeable temperature. I think this mineral water is the hottest in Italy, the hottest indeed that I have anywhere encountered except in one part of Japan. The bathing establishment, like almost every other building in use now, is new and only getting into good working order; its arrangement is sufficiently good to be tolerated by those who believe in the virtue of the waters. These baths, as might be supposed, are frequented chiefly by invalids with chronic rheumatic and gouty affections, disease of the kidneys and certain forms of skin disease. A great inconvenience in connection with the baths is that most of the patients have to travel a mile or more when returning from their hot bath as well as going to it, the bathing establishment being that distance from any neighborhood that can be called residential. But for this drawback these baths for the affections above referred to ought to be exceptionally beneficial. For two weeks before the earthquake before mentioned these waters gradually became hot beyond precedent, and in consequence of predictions based upon this fact large numbers of visitors intended to leave the island on the Monday following the Saturday night when everybody at the grand ball of the season was crushed and mutilated almost beyond recognition.

The Baths of Voltaggio.—Voltaggio is resorted to as much for its climate as for its baths. From Genoa this place is reached by a steadily ascending railroad ride of an hour and a half and a carriage ride of about forty minutes—in all, within two hours. Thus in midsummer one may be at Genoa in a temperature of 95° or more, say at four o'clock in the afternoon, and dine and sleep at Voltaggio in a temperature as low as 65°, though the actual distance between the two places is less than forty miles. The baths at this place are of a totally different type from those of Casamiciola. The basis of the establishment there is a particularly cold, bright and clear mountain spring and the establishment might be described as a hydropathic institution in which these waters are employed in all the various ways common to such institutions of the highest class. The establishment receives from 100 to 300 guests at a time. The diet is equal to that of the best hotels and includes excellent wine *ad libitum*, the inclusive charges ranging from ten francs a day upward. The administration includes a resident business manager and secretary and the resident physician, Dr. Barco, while the whole is under the supervision of Professor Queirolo, M.D., of the University of Genoa. A more healthful, cheerful and well managed hydropathic institution I have never found in any country, yet I have never seen or heard of an Englishman staying there.

The Baths of Casciana.—These baths are reached in about an hour and a half either from Leghorn or from Pisa, being half an hour's ride by train and an hour's ride by carriage. They are thirteen and a half miles from Leghorn, fifteen miles from Pisa and thirty-seven miles from Florence; but as Casciana, like Lucca and most other baths, is approached by a steady ascent, the time in reaching it seems disproportionate to the distance. I was led to visit Casciana, not by its general reputation, but by particular cases I met at Capri, at Sorrento and at other places, the remarkable benefits alleged to have been received by these individuals making me incredulous. One of these persons was a sprightly German officer who had been for years previously unable to walk owing to chronic rheumatism. A second was an Italian engineer who had been disqualified for work by neurasthenia; and another, an Italian baron, who for years had been disabled by nephritic calculi, etc. My incredulity was encouraged, not only by the greatness of the alleged results in the rheumatic case, but by the variety of the diseases from which the victims of them thought they had been relieved. After one of the most beautiful drives I have ever taken I found Casciana nestled among charming hills in the heart of rural Tuscany. The village itself is not attractive. It consists now chiefly of houses adapted to lodging and *pension* purposes, all subsidiary to the staple occupation of bathing and paying, giving baths and subsistence and being paid. All the baths are in the basement of one building, the "Sta-

biliamenta," which flanks the Central Piazza. The upper part of the building forms the Grand "Stabiliamenta Hotel," and contains ball, reading, billiard rooms, etc. The mineral water here is steaming warm, but is not comparable in heat to those of Casamiciola. The following is its composition:

Nitrogen	444·010	cubic centimeters.
Carbonic acid	967·770	" "
Sulphate of calcium	523·17	grammes.
Carbonate of calcium	100·35	"
" " magnesium	6·96	"
" " iron	1·02	"
Sulphate of magnesium	90·48	"
" " sodium	127·80	"
Chloride " "	7·80	"
" " magnesium	5·40	"
Ammonia	0·45	"
Silicic acid	11·55	"
Oxide of aluminum	2·46	"
Organic material	0·03	"
Lithia	A trace.	
Total solid matter	878·07	"
Pure water	299·12	liters.
Density	100·302	"

The baths are all constructed of Carrara marble, are in rooms for one, two or more persons and are reached by marble steps. One "treatment," as it is called, consists of from fifteen to twenty immersions within about two, three or four weeks, the duration of the immersions increasing gradually from fifteen minutes to an hour. After each bath the patient rests from half an hour to an hour in bed. The native residents of the region and throughout Tuscany show great confidence in the merits of these baths, which to the poor among them are given for fifty centisimi per bath. The visitors in the Grand "Stabiliamenta Hotel" included many annual *habitues* of the highest social rank, and as even the noblest Italians prefer any audience to no audience at all, I found it extremely easy to become the confidant of a large number and variety of their experiences. Of the whole number, not one of these persons had any accusation against the baths. The larger part spoke very hopefully and a solid proportion furnished tales corresponding to those which had made me incredulous enough to come and see what I could find for myself.

I watched several cases during my six weeks' stay there, but though some patients stated that after the first or second bath they at once improved, such changes were not visible to me. One very remarkable fact on which nearly all agreed who had been to these baths before or some time since, is that the real and greatest benefit began to be realized only some weeks or months afterward, and this in cases in which at the time and soon after taking the baths there was apparently not a particle of benefit. One such case has been under my own notice. This patient had for nearly twenty years been in a state of disability from neurasthenia, and after spending three years in the tropics with only partial relief from rheumatism and sciatica, had to return to England and took these baths *en route*. The benefit, which he really did not expect, amounted practically to nothing at the time, and almost immediately after reaching England he became bedridden with lumbago and sciatica; then came on the cold damps of November for which London is so distinguished, but through it all he has since remained better in every respect than he had been for ten or twelve years before. As this history nearly coincides with that of so many others given me by the patients themselves, my former incredulity is giving place to the question, "How do you account for it?" While waiting for the answer to this question the facts which have at least gained my respect ought, I think, to be known, and I offer them for the benefit of such as they may concern. It is a great advantage to be living in the building in which the baths are situated. This is especially felt in returning from them for the usual rest in bed afterward. The vice-director of this establishment is a physician, Dr. Fairman. The director is Professor Pietro Grocco, of Pisa. Every medical appliance, whether for electrical or other modes of combined treatment, may be found there in skillful hands. I never saw an Englishman or an American in this establishment, though it seems to me to be well worth a trial, especially in cases of chronic rheumatism and allied ailments.—*London Lancet.*

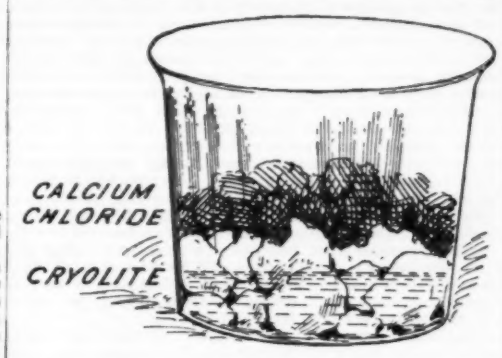
THE ANTI-EMETIC ACTION OF MENTHOL.

DR. R. BLONDEL has recognized this action of menthol for the past five years, regarding it, with carbonic acid, as the most surely anti-emetic of those with which he is acquainted. He notes that both of these remedies are stimulants to the stomach, powerful adjuvants to gastric contraction, and frequently employed in moderate dose to stimulate sluggish muscular work of the stomach; that with the use of menthol nausea and gastric spasm can be stopped at such a point that even ipecac loses its power of producing emesis. He seems to believe that the active stimulant effect of these remedies is produced on contractured muscular fiber. He utilizes this property of menthol in the treatment of dysentery by ipecac, when he administers with it every two hours a fifth of a grain of menthol dissolved in alcohol, to which a smaller quantity of saccharin is added.—*Nouveaux Remedes.*

PHOSPHATES IN MILK.—Duclaux. (*Ann. Inst. Past.*, 1893, vii. 2, through *Chem. Zeit.*)—According to the experiments of the author, the phosphates in milk are present in suspension and solution. The former are phosphates of iron, aluminum, magnesium and calcium, while the latter consist of nearly equal molecular quantities of phosphate of sodium and phosphate of calcium, held up by sodium citrate. The result of the examination of various kinds of milk is that there is about twice as much calcium phosphate in suspension as in solution, and that the composition of the ash of milk of the most diverse origins is very nearly identical. An attempt to produce a "phosphate milk" by adding phosphates to the fodder has proved quite ineffective, the milk containing no more phosphate than ordinary qualities.

PROTECTION OF IRON AND STEEL SPECIMENS.

A COLLECTION illustrating the various steps in the manufacture of iron and steel was gathered in Pennsylvania by the late Dr. J. Francis Williams for the Technical Museum of the Pratt Institute. The specimens were preserved in dust-proof cases which were not perfectly air-tight. Soon the fractures began to oxidize. As a preventive, bottles of sulphuric acid were introduced into the cases, but without effect. As a last resource, beakers filled with lump calcium chloride were placed in the cases. This proved successful, and an examination of the specimens, after the lapse



of more than a year, showed that none of them had oxidized. Calcium chloride has a strong affinity for water, and this well-known property has been taken advantage of in many chemical operations. The deliquesced salt, with the water extracted from the air, forms a thick liquid, formerly called *oleum calcis*. When the beaker was entirely filled with the calcium chloride, some difficulty was experienced on account of the liquid covering the lumps and rendering the calcium chloride inoperative. This was remedied by covering the bottom of the beaker with some mineral which would raise the lumps of the calcium chloride above the highest level of the liquid. Almost any non-soluble mineral can be used, but Greenland cryolite, being at hand, was used, as the color nearly resembled that of the calcium salt. The beaker required emptying weekly.

Calcium chloride is used by manufacturers and dealers to prevent rust in fine cutlery, surgical instruments, guns, watchmakers' tools, etc. Platinotype paper suffers under the disadvantage of being injured or entirely spoiled by the moisture of the atmosphere; so special tubes with a calcium holder are provided, which enables the photographer to keep the paper perfectly for several months. It is also largely used by the chemist in drying gases, etc. Calcium chloride is cheap, and can be employed with advantage in many of the arts.

PREPARATION OF LIQUID ORGANIC EXTRACTS.*

By C. E. BROWN-SEQUARD, M.D. Paris, F.R.C.P. Lond.

THE medical profession owes a great deal to D'Arsonval for the various forms of apparatus he has contrived for this preparation, and especially for the

STERILIZING FILTER OF D'ARSONVAL.

admirable filter he has succeeded in obtaining after long and most careful attempts. The following is from a paper by D'Arsonval, and relates to the preparation of all the organic extracts, as well as that of the testicular (which we call orchitic) liquid:

1. We procure testicles of bulls at the slaughter house. Just after the killing of the animal a ligature is placed as high as possible on the whole mass of the spermatic cord, so as to get at least a certain amount of the blood contained in the veins. When the organs reach the laboratory their coverings are at once cut away with scissors sterilized by heat. The organs are then washed in Van Swieten's liquor, and afterward in recently boiled water. That being done, each of the testicles is cut in four or five slices, which, with the piece of cord, are placed in a glass vase, in which is thrown, for each kilogramme of the organs used, one liter of glycerin marking 30°. The vase is covered, but it is essential, during the next twenty-four hours, to turn over a good many times the slices and other pieces of organs. At the end of that period an addition of 500 cubic centimeters of freshly boiled water, containing 25 grammes of pure chloride of sodium, is made. The liquid so obtained is then made to pass through a paper filter (we use the sirup gray filter No. 8 of the Laurent series). Before doing this, however, we hardly need to say that the paper filter and the glass funnel in which it is placed must be thoroughly washed with boiling water. The filtered liquid is slightly rose-colored. To hasten the filtration it is well to raise the temperature of the glyceric solution to 40° C. (104° F.); the viscosity is thereby suppressed.

2. Of the various means we have made use of to obtain a liquid absolutely free from microbes or other dangerous pieces of solid matter, the most important is the one we will now describe. The sterilizing D'Arsonval filter, represented in the annexed figure, is composed of a metallic hollow cylinder, S, which receives and keeps immovable the thick steel bottle, B, filled with liquid carbonic acid; a metallic tube, F F, which has borne the weight of 300 atmospheres; a metallic stopper screwed on the lower extremity of this tube, and carrying the filtration bougie, *b*. This bougie is of a kind of clay in which kaolin is replaced by pure alumina; it is fixed on the metallic stopper by an India rubber tube, which is made to press most tightly on the bougie and the metal. A screwing top, V', is attached to the metallic stopper, and by it we can at will close or open the apparatus. When it is opened, the liquid which has passed inside of the filter, *b* runs out through the tube, *a*. The top of the tube, F F, is closed by a metallic stopper, V, which is surmounted by a manometer graduated up to 100 atmospheres, and carries also a screwing tap, which allows the escape of the accumulated carbonic gas when this escape is needed. An adjoining lateral tube, E, serves for communication between the sterilizing filter and the liquid carbonic acid contained in the steel bottle, B. A stopper, R, with a steel point, put in action by a key, C, gives the possibility of establishing or stopping communication between the two tubes, B and F F, so that the pressure against the liquid which is to be filtered may be gradual. The two tubes or pieces of apparatus form a whole, fixed on a wooden tablet, S, which is screwed firmly on a table. To sterilize the glyceric liquid it is first thrown into the tube, F F; then, after having screwed solidly the superior stopper on which is the manometer, M, and having turned to the end the closing screws, V and V', the tap, R, of the steel bottle, B, is opened. The carbonic acid enters rapidly into the tube, F F, and presses over the liquid. A pressure of 50 to 60 atmospheres is maintained for about an hour, during which all the microbes that may be present are crushed and killed. The pressure may be increased, notably if the apparatus is submitted to a temperature of 40° C. (104° F.) Neither the albuminoids nor the soluble ferments are in the least altered, as has been ascertained with pancreas and yeast. When the sterilization is considered sufficient (from half to one hour for tissues of a healthy animal), the tap, V', is opened, and the liquid filters rapidly through the bougie, *b*, after having been submitted to two sterilizations, the first one by CO_2 under pressure, the second by the filtration.

IMPROVEMENTS IN THE MANUFACTURE OF BORAX.

By H. N. WARREN, Research Analyst.

BORACIC or boric acid, as is well known, is one of the feeblest acids to be met with, being readily replaced by all other known acids, and even in some respects by carbonic acid; but, on the other hand, viewing it as an anhydride, we find it standing foremost, and at elevated temperatures even slowly replacing such acids as phosphoric and sulphuric acids.

Boric anhydride is, in fact, when pure, almost entirely fixed at the most elevated temperatures obtainable. A tared platinum crucible containing an ounce of the substance which had been exposed to a full white heat for over two hours was found, after weighing, to have lost in weight but five grains. The peculiar properties of the acid, however, are vastly different, volatilizing readily upon the application of heat, insomuch that it is practically impossible to distill a solution containing boracic acid without a portion passing into the distillate. Again, if boric acid is melted at a low red heat in a platinum or other suitable vessel, as long as aqueous vapors are discharged, volatilization of the boron present is perceptible until about 70 per cent. of the water present is discharged, the remaining portion of the water being expelled in an almost pure condition.

Taking advantage of these properties, the author has devised a method by which the production of borax is brought about by subjecting common salt (sodium chloride) to the action of the crude boracic acid of commerce aided by superheated steam, the decomposition being effected by employing large clay retorts, composed for the most part of acid-resisting material, the tops being tubulated to allow of the introduction of the steam required during the reaction. The retorts being charged with an intimate mixture consisting of well ground salt and boric acid, the neck of the retort being connected with a refrigerator for the purpose of condensing the acid thus obtained.

Directly the retorts assume a low red heat, hydrochloric acid is disengaged in abundance. The heat is now slightly raised, and the supply of steam so regulated that water in the form of steam is allowed to enter through the tubulure in sufficient quantity to condense the hydrochloric acid formed in connection

* From the *British Medical Journal.*

with the refrigerator, the result being a speedy and complete decomposition of the salt employed, with the production of anhydrous borax, which remains in the retorts, while a dense and pure acid collects from the condenser.

When the reaction is terminated, the contents of the retorts, consisting of anhydrous borax, is ejected, while still red hot, into cold water, where it is allowed to remain for forty-eight hours, during which time it will have passed into solution, from which, by the ordinary routine of crystallization, it is obtained as ordinary commercial borax.—*Chemical News.*

SULPHATE OF AMMONIA AS A MANURE.

IN a monograph on the use of nitrogenous manures read at the conference of the Old Students' Association, Gembloux, the following particulars concerning sulphate of ammonia are given:

Sources.—Gas works, sewage, distillation of organic materials, condensation of the nitrogen from products of combustion, distillation of schists, etc.

Conditions of Sale.—The price of the nitrogen of nitrate of soda should be compared with that of the nitrogen of the ammonium salt.

Adulterations.—Common salt, kainit, ferrous sulphate, etc.

Behavior in the Soil.—It decomposes more or less rapidly in contact with the carbonates of the soil (carbonates of lime) and is converted into ammonium carbonate. This combines with the clay and the humus, forming insoluble compounds, and this prevents the spontaneous dissemination of the fertilizer throughout the soil.

Ammonium carbonate is volatile and may escape into the air when the decomposition of the sulphate is too rapid (calcareous or recently limed soils) or when it is formed at the surface of a soil which is too dry and poor in humus and clay. When a soil presents favorable conditions of aeration, moisture, and temperature, the nitrification of the ammoniacal nitrogen takes place rapidly. It usually requires about a fortnight or three weeks (Muntz & Girard, Schloesing).

The nitrate formed, chiefly nitrate of lime, dissolves, spreads throughout the soil and can then be removed by water just in the same manner as nitrate of sodium. Statements to the effect that the ammoniacal nitrogen being fixed by the soil could not be lost in this way are therefore erroneous. The annual loss by drainage is nevertheless a little lower than that of nitrate of soda.

Nitrogen being absorbed most freely by the roots in the form of nitrate, it follows that sulphate of ammonium cannot act so quickly as nitrate of sodium; notwithstanding this, it is a rapid fertilizer as compared with other nitrogenous manures. Sulphate of ammonia also produces certain secondary effects. Prepared from about 60 per cent. of its weight of sulphuric acid, the latter is transformed during the decomposition into sulphate of lime or plaster of Paris. Now, this substance appears to act as a stimulant to the nitrification of nitrogenous materials. The carbonate of ammonium we have said combines with the clay as soon as it is formed; this clay contains among its constituents a certain amount of potash which is not easily attacked by the ordinary solvents. The ammonia replaces this potash and thus renders it available for assimilation. Sulphate of ammonium sometimes produces injurious effects upon plants, shown by the development of a yellow color and a drooping appearance. This is no doubt due to the causticity of the carbonate of ammonium which is formed (this action is sometimes produced with fresh manure). Finally, when the sulphate is badly spread and comes into contact with the seeds, it may injure their germination.

General Principles for the Use of Sulphate of Ammonium.—From what has been stated it follows that sulphate of ammonium is not suitable for calcareous soils, nor for land in which the nitrification is hindered by the soil being too compact, too moist, or too acid.

To decide upon the time at which to apply the sulphate, it is necessary to consider the period which it requires for nitrification. Applied at the time at which vegetation is commencing to develop, no effect will be produced until after the elapse of the requisite number of days, varying according to the more or less favorable conditions of the soil and the activity of the microbes.

Concerning the dissemination of the sulphate in the soil it is to be observed: (a) That it may be treated in the same way as nitrate of soda, except that it must not be mixed with basic phosphate or lime. (b) That simple spreading on the surface of the soil is not sufficient to insure the dissemination of the sulphate in the arable layer. The nitrogen may continue for a long period in the ammoniacal condition in the surface layers during dry weather and may even escape into the air. It is also under these circumstances that the injurious effects on plants are produced.

It follows from this that the manure should always be well worked in. Its use as a top dressing without subsequent harrowing and second dressing should be strongly discountenanced. The nitrogen of sulphate of ammonium, like that of all other manures which readily undergo nitrification, being liable to be washed away by drainage water, compels the application of more than the necessary amount and prevents its being applied too long in advance. Experiments made at Rothamsted prove that the plan of applying in the autumn, which is advised by some, necessitates considerable losses.

In general it should be applied in the spring, a little sooner than nitrate of soda, on ground containing the winter-sown crops and a few days before the spring sowing or planting. In this way it will exert its action at a useful time and the injurious effects are guarded against.

In any case, leguminous seeds being sensitive to the caustic action of ammonium sulphate, sulphate should not be used as a top dressing for cereals on which it is intended to sow clover. Heavy rains following the application of this fertilizer do not have the same bad effect as in the case of nitrate of soda. On the other hand, the sulphate is less adapted for stimulating growth after the frosts of a cold spring or for rapidly imparting vigor to plants attacked by insects.

The very contradictory results obtained in experiments having for their object the comparison of the agricultural value of sulphate of ammonium and nitrate of soda are, we believe, largely due to the fact that the principles which must be observed in the use of the sulphate have been, to a great extent, overlooked. Moreover, the secondary effects which may be produced by manures have, to some degree, been lost sight of.

SAVOY CABBAGE.

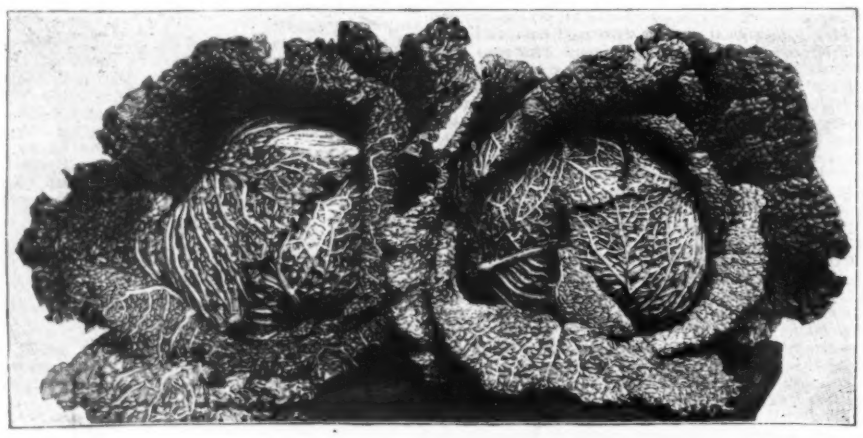
NEXT winter's prospects are none too rose colored to those who look ahead and are cognizant of what is going on in private and market gardens. Never before probably has there been so much difficulty experienced in rearing plants in the open of the various members of the Brassica family. What early seedlings came up, thanks to frequent waterings, were quickly cleared off by the turnip fly, and later sowings have fared nearly as badly. Those who early realized the difficulty they were likely to be in ought to have at once utilized spare frames for raising what plants they required, this being a good plan up to the second or third week in May, after which it is doubtful if it will work well. Brussels sprouts, being usually raised under glass and got out early, are not likely to be scarce, autumn cauliflowers and broccoli also being fairly plentiful, but main crop and late broccoli, borecoles and Savoys are not. Broccoli can be and is very often dispensed with, but not so borecoles and Savoys. It is the latter species that would be missed most during the early part of winter, and which also would in my case be ill spared, owing to their being preferred on the dining table to Brussels sprouts.

Savoys, if not too well grown, are of mild flavor and very tender when cooked, and none more so than the small early forms, such as Tom Thumb, Early Dwarf Vienna and Golden Globe. To these Early Dwarf Ulm forms an admirable succession, this variety being also excellent when cooked. Then come Dwarf Green Curled and Gilbert's Universal, the latter being the superior in point of quality; and the former, not requiring much room, also proving moderately hardy, is still worthy of general cultivation. Drumhead, of which a remarkably well executed woodcut accompanies these remarks, is indispensable on account of its lateness and hardiness, but, all the same, is the coarsest of the lot.

Savoys generally succeed well on somewhat cool borders, and, in fact, these are the best sites for them in most southern localities, as they are apt to heart in long before they are wanted if given warm quarters, many being spoiled accordingly. Seed is often sown much too early, leggy plants, or, it may be, if the planting is done early enough to prevent this, early hearting in, no matter where planted, is the outcome. If the seed is sown late in April or during the first week in May, this is quite soon enough for most places, the plants being ready by the time the ground is fit for their reception. They ought to have fairly rich, moderately firm ground. With me they form a good succession to leeks without any further preparation beyond leveling over the surface after the previous crop was cleared off. This season early and second early peas will be off the ground quite soon enough for Savoys, and seeing that the latter do not last long after midwinter, these sites, if not wanted for broccoli, may well be utilized for Savoys, especially if the latter were raised unusually late. There is no necessity to dig ground cleared of peas or other early crops for Savoys, but after the weeds and rubbish have been got off and a surface hoeing given, drills may be drawn with a heavy hoe, filled once or twice with water, or better still, liquid manure, and the planting be then done. I have had remarkably good and exceptionally hardy Savoys from ground newly cleared of strawberries, but these sites, being the likeliest to produce hardy broccoli, are most often given up to the latter crop—rightly so, too

If large Savoys are most preferred, then by all means plant on heavily manured, deeply dug and only moderately firm ground, also allowing the different varieties plenty of room: but who cares for large Savoys? As before stated, it is the neat, close, but not solid hearts that are much the best when cooked, those great solid much-blanched and bursting hearts very often seen being more fit to go with cow cabbage. The illustration of Drumhead partly conveys what I mean, these not being overgrown and not too solid, and white in the center. This variety must form a certain number of strong outside leaves, or it will fail to heart in properly, but if the plants are put out 18 in. asunder in rows 2 feet apart, that is ample room. Supposing these are arranged at the back of a border or quarter, Dwarf Green Curled and Gilbert's Universal should come next, 18 in. apart each way being plenty of room for these, and rather more than they often get with me Next plant Dwarf Ulm, allowing this variety 15 in. each way, and finish off with one or more of the early dwarf varieties I have already named, 12 in. each way being ample for either of them. Should the weather continue hot and dry, it will be found a good plan to give the plants in either seed or nursery beds a good soaking of water a few hours previous to moving them, and also to replant in drills previously well moistened. Plants that have been pricked out should always be lifted and transplanted with a trowel, but those drawn from seed beds can best be replanted with a dibber, the soil being made firm about the roots in either case. Every second evening or so till the plants are growing strongly the drills about them ought to be filled with water, after which the ground may be leveled, or, better still, if the stems are long, soil can be drawn up to these from each side. Later on, if the plants present a blue, starved appearance, the furrows between them should have liquid manure freely poured along them, and this will soon alter the color.

Those who have too few plants to put out and cannot well procure them elsewhere should try a plan that has frequently answered capitally in the case of borecoles as well as Savoys, viz., that of sowing the seed late where the plants are to remain. The early and second early varieties are to be preferred for this experiment, the seed being sown thinly in drills drawn one foot apart and watered in advance of sowing. Keep the seedlings dusted over with soot and lime to ward off slugs and turnip fly, and only lightly thin out. Should the autumn be favorable to late growth, large quantities of neat and very acceptable hearts will be available next winter, and even green tops will be appreciated.—*W. I., in The Garden.*



SAVOY DRUMHEAD.

Engraved for *The Garden* from a photograph sent by Mr. Norman Blake, Bedford.

POISONOUS PLANTS AND THEIR POISONS.

By J. GUARDIA, F.R.M.S.

NOT only to naturalists, but to every reader, some knowledge of poisons is, I think, likely to prove welcome. Every one must be aware of the great lack of satisfactory information on this head, as is painfully evident from the almost daily reported cases of death or illness through poisoning—cases which are the more distressing when we consider that most of them might have been avoided by even a slight acquaintance with the dangerous substances with which we are surrounded.

But it is scarcely from a medical point of view that I wish to treat of poisonous plants—this has been done in several excellent English and foreign treatises. What I desire to do is to present a new field of inquiry to those who have not previously paid any attention to the most wonderful properties developed in the world of plants; and also, by giving a series of remarkable facts, to induce an interest in our plants for their own sake, and thus, possibly, to counteract the too general tendency (chiefly) among young collectors, to consider each new specimen merely as hay of a different shape, fit only for another sheet in their herbarium!

We will examine the nature and effects of the different poisons, and, after passing in review the most poisonous plants of our native flora (with a few of the most noteworthy exotics), we shall attempt to explain how and why their poisons were produced.

What is a poison? And however easy to answer it may at first appear, it will be found by no means so. The dictionary's definition of the term is notably incorrect. The dictionary has it that a poison is "that which is destructive or injurious to vitality." Now this sounds well enough, yet it is not sufficient. A poison is a substance which can exert, by its chemical action, an injurious influence on the vitality of a healthy organic body or tissue.

But it must be acknowledged that to define correctly what a poison is, is very difficult, if not impossible, as many substances injurious to some organisms are by no means so to others. For instance, the deadly nightshade and the henbane do not poison pigs. The water-hemlock, so dangerous to man and notably so to cattle, is perfectly harmless to dogs, as is the celandine to sheep and the spurge to goats. Noteworthy, too, is the case quoted in the "Origin of Species" of white sheep and pigs being injured by certain plants, while dark-colored individuals escape. "Professor Wyman," adds Darwin, "has recently communicated to me a good illustration of this fact: on asking some farmers in Virginia how it was that all their pigs were black, they informed him that the pigs ate the paint-root, *Lachnanthes*, which colored their bones pink, and which caused the hoofs of all but the black varieties to drop off" ("Origin of Species," sixth ed., p. 9). The toxic effects which such vital substances as blood and pollen produce in some cases are most remarkable. A few drops of the blood

of a mammal, if introduced into the circulation of a bird, causes a certain and intensely violent death by the instantaneous destruction of the vitality of its nervous system (Dieffenbach). Fritz Muller has recorded some species of plants, the pollen of which, if placed on the stigma of the same flower, acted on it like a poison, the flower fading and falling off, and the stigma turning brown and decaying. Sugar is said to kill almost instantaneously some reptiles, like frogs and lizards. The dose or quantity of a substance required to poison an animal also differs greatly; while a very small quantity of opium is sufficient to kill a man, it requires two drachms to kill a dog, and as much as two ounces for a cow; yet one ounce given to sheep, it is said, will have no bad influence on these animals. Swallowing two or three drachms of arsenic will have no dangerous consequences for a horse. Man, as well as animals, can gradually become used to some poisons. Mythridates, king of Pontus, had made a special study of poisons, and had even written a book on them. He accustomed his body to the strongest of them by taking at first small but gradually increasing doses, so as to protect himself against being poisoned. The opium smoker can stand a quantity of that drug that would be most dangerous to us.

In spite of these anomalies, the definition of poison given above is probably correct, and keeping it in mind we will now throw a rapid glance on the nature of poisons. Poisons are represented in all the three kingdoms of nature; there are, therefore, *animal, vegetable* and *mineral* poisons. And without taking into account the kingdom from which they proceed, poisons may be again divided by the different modes of action of their deleterious effects. Those called acrid or irritants act by inflaming the parts with which they come in contact. The plants whose poisons belong to this class are the spurge, colocynth, savin, most *Ranunculi*, the meadow-saffron, water-dropwort, etc. The narcotics, without producing any immediate change on the surface exposed to them, act on the brain and nerves, inducing a tendency to insensibility and torpor. The principal are the henbane, bitter-sweet, *Lactuca virosa*, and all plants containing opium or prussic acid. The third class, that of the narcotic irritants, partakes of the qualities of the other two classes, and comprises the strongest poisons. The most common plants of this class are the deadly nightshade, thorn-apple, tobacco, foxglove, hemlock, cowbane, "nux vomica" and the poisonous fungi. Camphor, turpentine, ether, and alcohol also belong to these.

The toxic properties of plants are due to certain substances contained in them, most of which have already been studied and extracted by chemists. These substances are generally of an alkaline nature, and called *alkaloids;* some are acid. The vegetable kingdom produces about 1,000 alkaloids, of which about 200 have become at all accurately known—a good number, considering that their existence was discovered only three-quarters of a century ago, *i. e.*, by Lerturner in 1816. Most of them are violent poisons; among the best known I may name morphine, codeine, strychnine, aconitine, nicotine, coneine, atropine, hyoscyamine, etc. The acids are either united to alkaloids or to oils.

There are various ways by which these poisons may be accidentally introduced into the system. Through the nose, in the form of odors; through the lungs, by inspiration; by the mouth, in the form of food; through the skin, by absorption; and, very readily, by recent wounds. They act either on the nerves and brain, on the blood, or on the tissues of the body. Opinions seem to differ as to whether poisoning in general takes place primarily through the nerves or through the blood, and facts are brought forward to support both theories. It is, for instance, said on the one hand, that after cutting the gastric nerves no poisoning takes place in some cases, and that a solution of emetic tartar, if injected into the veins, causes nausea in the stomach by acting through the nerves. On the other hand, it is stated that prussic acid, which otherwise acts on all tissues, animal and vegetable, has no influence whatever if brought in contact with the nerves only. Strychnine produces no effect unless it gets into the blood, as the celebrated German physiologist, J. Muller, proved by the following interesting experiment that poisoning cannot take place through the nerves alone. He exposed the nerves of the legs of some toads, so that the calf and thigh were only connected by the bones and nerves. Then he placed the legs for a long time in an acid solution of morphine and a concentrated solution of opium. Many hours afterward the toads were still alive and perfectly sensible.

It seems, however, that poisons in general, whichever way they may be introduced into the body, kill by finally acting on the brain through the nerves. It is worth noticing that opium, morphine, belladonna, alcohol, etc., chiefly act directly on the brain; strychnine, tobacco and camphor on the spinal cord; aconite, cicuta, colocynth and colchicum on the ganglion system. The upas and wourali poisons, like that of venomous snakes, act by altering and decomposing the blood.

Of all poisons, those of vegetable origin are perhaps the most common and certainly the most violent. Unfortunately they are also the most difficult to determine, for while nearly all mineral poisons are well known and comparatively easy to analyze, and the poisons of animals readily obtained in a pure state for study, the poisons produced by plants can only be extracted after a lengthy process of distillation—too lengthy, indeed, and, besides, too varied to be described here. The toxic agents of many plants have not been discovered yet, and of those that are known, only a few, such as strychnine, morphine, brucine, etc., have been subjected to a thorough study. The result of this is, that while there are numerous tests by which to identify mineral poisons, the determination of the vegetable alkaloids is, mostly, very uncertain. The toxic products of plants are determined by two methods, *i. e.*, by their reaction when subjected to certain chemical agents or to the blowpipe, and by a microscopical examination of the crystals of the alkaloids. As to chemical tests, the following may be of interest:

Iodic acid stains all vegetable alkaloids brown.

Morphine gives a blue stain with chlorate of iron or gold; sulphuric acid turns it first yellow and then red.

Strychnine.—Sulphocyanide of soda, if introduced into a solution of strychnine, soon causes the crystallization of the alkaloid.

Veratrine is turned milky by the same reagent.

Emetine is turned milky by the same reagent, and yellow by chlorate of platinum.

Brucine is turned first pink by concentrated sulphuric acid, and then deepens to blood-red.*

The crystallization of alkaloids is of a very constant character in each case, and the microscopical examination of their crystals often enables us to identify the alkaloids when other means fail, on account of their not being affected by the usual reagents in the very diluted state in which they are sometimes found. Here, then, we must again seek the aid of the most entertaining and at the same time most useful of scientific instruments—the microscope; and we shall obtain, as usual, the most surprising and wonderful results. The smallest crystals of alkaloids can be determined by examination under the microscope. Dr. Wormley states that micro-chemical analysis enables us by a very few minutes' labor to recognize with unerring certainty the reaction of the 100,000th part of a grain of prussic acid or arsenic. Fluids containing alkaloids in such minute quantities as would not answer to chemical procedure may be detected in the following way: A drop of water containing infusoria is placed, uncovered, on a slide, and while this is being examined under a suitable power, a little of the suspected fluid is applied, when, if an organic poison be present, the infusoria falls in a formless sediment. The 15,000,000th part of a grain of atropine, it is said, may be thus detected! (Professor Rossbach.) In fact, as the late Dr. Carpenter says, in the last sentence of his work on "The Microscope": "By the careful prosecution of micro-chemical inquiry especially with the aid of the spectroscope (where admissible), the detection of poisons and other substances in very minute quantity can be accomplished with such facility and certainty as were formerly scarcely conceivable."

After this necessarily short sketch of the nature, properties, and effects of vegetable poisons, I will proceed to enumerate, as briefly as possible, the different cases in which poisons occur in the plants of the British Flora, etc.

The first natural order, that of the RANUNCULACEÆ, is a very poisonous one, almost all of its members possessing more or less strong acrid or narcotic-acrid properies.

Anemone pulsatilla, nemorosa.—The pasque-flower and wood anemone contain an acrid alkaloid, anemonine, which acts chiefly as a caustic by inflaming and blistering the skin. One and one-half oz. of the fresh juice of *pulsatilla* introduced into the stomach of a dog caused its death after six hours. *Nemorosa* is not as strong in its effects.

Ranunculus.—Most of our buttercups contain an irritant substance, which is strongest in *acris*. Three oz. of the juice of *arvensis* killed a dog in four minutes. The juice is so caustic that the hands of children sometimes are inflamed and blistered by grasping their bruised stems in hot weather. Beggars are said to employ them to ulcerate their feet and legs for the purpose of exciting compassion. *R. aquatilis* is destitute of this acrid principle, and the others lose it if completely desiccated.

Helleborus fœtidis and *viridis* contain a fatty oil which is a narcotic irritant. Two dessertspoonfuls of the infusion of *fœtidis* killed a child in thirteen hours. A decoction of ½ drachm of the root of (*H. niger*)† killed a strong horse in ten minutes, and even its pollen is believed to be poisonous.

Delphinium Ajacis and (*Staphis agria*).—The larkspurs produce an acrid alkaloid, delphinine. This is present in the leaves and stems, and, in great quantity, in the seeds, which are very poisonous.

Aconitum napellus.—The pretty monkshood, so often grown in our gardens, is a most dangerous plant. Every part of it is full of a narcotic-acrid alkaloid, the aconitine, of a very deadly nature. When taken it produces a feeling of great constriction in the throat, sometimes amounting to choking, and even a small dose often leads, through madness, to death. Chewing one single seed will cause an alarming and painful swelling of the tongue and lips. The toxic nature of this plant has been known since the days of the Romans. The resemblance which its leaves bear to parsley, and its root to horse radish, render it all the more dangerous. The root of the monkshood is fusiform, black, and gives off numerous rootlets; that of the horse radish is much longer, of a more uniform thickness throughout, yellowish in color, and with only a few root fibers. The juice of (*A. ferox*) is so violent that it is used in India for poisoning the arrows of tiger traps, etc.

PAPAVERACEÆ.—*Papaver somniferum*, etc.—The thick, milky fluid that oozes from the stem of a poppy when cut is powerfully narcotic, and furnishes the opium of commerce. Opium is obtained from incisions made in the unripe seed vessel of the oriental plant. It contains several poisonous alkaloids, viz., morphine, narcotine, meconine, thebaine, etc., and its effects have been often described. It acts as a poison on all animals, and even on some plants; it can enter the system by different ways, and soon diffuses itself throughout. A person has been poisoned by simply holding a lump of opium in the hand on a hot day. In small doses, ¼ to 1 grain, it excites all the physical functions and increases the activity of the brain. The dose required to poison a man varies very much with the person and habit, and, of course, opium smokers can absorb a quantity of the poison which to us would prove dangerous. *Laudanum*, an alcoholic solution of opium, in great use for allaying pain, is stronger than a simple aqueous solution thereof, as morphine, the narcotic principle, is readily soluble in alcohol, but not in water. It should, therefore, be carefully used, as three drops have been known to kill a child. All our other poppies have juices similar in nature to that of the white species, but far less powerful in effect. The odor of the common red poppy, *P. rhœas*, has a well known, nauseous, stupefying effect.

Chelidonium majus.—The celandine has a violently acrid, orange colored juice. Its repulsive odor is, perhaps, the cause that cases of persons being poisoned by this plant are very rare. Still, three drachms of its extract will kill a dog in a few hours. The juice is said to cure warts and corns.

LEGUMINOSÆ.—This order of plants, which gives us our peas and beans, the clovers and vetches, besides logwood, gum arabic, balsam of Tolu, and many other useful products, also contains some very poisonous plants. And although most of the European species are devoid of any powerful prejudicial action, in some others the presence, in greater or lesser quantity, of a principle called cystine, renders them not only unwholesome, but, in certain cases, decidedly poisonous. The seeds of the beautiful (*Laburnum*) of our gardens, for instance, are considered highly toxic, and those of our yellow vetch, *Lathyrus aphaca*, are said to be unwholesome. (*L. sativus*) causes, if eaten, a strong rigidity of the limbs, and these, in some cases, become perfectly helpless. It seems to have a similar effect on some animals. The root of the kidney bean is also said to be dangerously narcotic. Among the principal exotic poisonous species of this order may be mentioned *Physostigma venenosum*, the seeds of which are known as the Ordeal Beans of Old Calabar; the bark and red juice of *Erythrophlæum Guineense* are also used as an ordeal in West Africa. The seeds of *Abrus precatorius*, a plant considerably talked about lately on account of its supposed meteorological propensities, are known as crabs' eyes. They are very poisonous; half a seed (a whole seed weighs about 1½ grs.) rubbed down with a little water and injected into the thigh of a cat will produce fatal effects within twenty-four hours. The roots, on the other hand, are known on the Continent as American licorice. The plant is a common one in the East and West Indies. Several species of *Derris* in the East Indies, and a *Piscidia* of Jamaica, are used to poison fish. No less than one hundred and fifty species of flowering plants are poisonous to fish, as Dr. Radlkofer has shown, and many of these are actually used for fishing purposes. As an illustration of this interesting action of the poisons of some plants, I may here give Bates' description of the way in which a poisonous liana, called Timbó, is used on the River Amazons:

"It will act only in the still waters of creeks and pools. A few rods, a yard in length, are mashed and soaked in the water, which quickly becomes discolored with the milky, deleterious juice of the plant. In about half an hour all the smaller fishes, over a rather wide space around the spot, rise to the surface, floating on their sides, and with gills wide open. The poison acts, evidently, by suffocating the fishes. It spreads slowly in the water, and a very slight mixture seems sufficient to stupefy them. I was surprised on beating the water in places where no fishes were visible in the clear depths, for many yards around, to find sooner or later, sometimes twenty-four hours afterward, a considerable number floating on the surface." Fish killed in this manner form perfectly wholesome food.

The ROSACEÆ, to which belong the useful trees that yield our cherries, plums, almonds, peaches, strawberries, apples, and pears, yet likewise produce one of the most deadly of narcotic poisons, *i. e.*, hydrocyanic or prussic acid. It is present in most members of the order, but principally in the almond tree, the laurel, in the kernels of all stone fruit, and in the leaves and flowers of the cherry, plum, peach, etc. The oil of bitter almonds is extremely poisonous, and even the exhalation of the leaves of the common laurel is destructive to insect life, as all entomologists know. Cases of children being poisoned through eating the kernels of cherries are on record. Prussic acid in its pure state kills almost instantaneously, be it inhaled or otherwise admitted into the system. It acts as a powerful poison on all animal organisms without exception, and proves almost as deadly to plants as to animals; so toxic is it, indeed, that its vapor will kill even plants that contain it in solution in their own sap.

CUCURBITACEÆ.—Another large and important order, which includes the melon, cucumber, gourd, vegetable marrow, etc. *Bryonia dioica*, the white bryony, is the only British representative of this order. Its large rootstock has a nauseous, milky juice of intensely acrid and cathartic properties. The bitter substance, bryonin, derived from it, though much used in medicine, can, when taken in large doses, cause convulsions, stupor, and even death.

(*Ecballium elaterium*) of the south of Europe, etc., produces an acrid juice in its fruit, from which is prepared the substance known as elaterium. When a fruit of this plant is ripe, it suddenly drops to the ground, and through the hole left by the stalk, its poisonous juice (which carries with it the seeds) is squirted out with considerable force. This has gained for the plant the name of spirting cucumber. A case is said to be on record, "when a person was taken dangerously ill from having merely carried a specimen in his hat!"

UMBELLIFERÆ.—*Conium maculatum.*—The hemlock contains an active principle named conia or coniin, which is highly toxic even in small quantities. It speedily kills most animals, but it is said that the plant is eaten by sheep with impunity. Conia acts on the nervous system and produces paralysis of the extremities before death, and this has been known to take place, in some instances, within an hour after the poison was taken. The juice of *C. maculatum*, probably mixed with opium, was given by the Athenians to citizens condemned to death, as in the case of Socrates and Phocion.

Cicuta virosa.—The water hemlock or cowbane is still more poisonous than *Conium*. It contains in its sap a volatile alkaloid, cicutine, which is fatal to cattle and man, but is said to have no dangerous effect on horses or dogs. The poison does not seem to develop till the summer months, as cows, it is stated, can eat the plant with impunity in the spring. This is, in a certain degree, analogous with the difference in the power of the poison of adders in cool and hot weather.

Œnanthe fistulosa, crocata, and *phellandrium.*—The water dropworts are perhaps the most virulent of umbelliferous plants, and the resemblance of the roots of *crocata* to parsnips, of the leaves of the same and of *phellandrium* to parsley, and of their shoots generally to celery, has led to disastrous results, by their being

* For further information on this point see any of the numerous works on medical chemistry, or Wittstein's excellent treatise on "The Organic Constituents of Plants," F. Von Muller's translation, Melbourne, 1878.

† Names between parenthesis marks ( ) refer to plants not native in Great Britain.

eaten by cattle and even children. The poisonous principle resides in the yellowish juice.

Æthusa cynapium.—The fool's parsley is another poisonous British umbellifer. Its odor is nauseous, and the plant, when eaten, has been known to give the 'lock-jaw," and to cause death in less than one hour. It may be easily recognized by the three or more slender bracteoles which hang from beneath each cluster of flowers.

COMPOSITÆ.—*Lactuca virosa.*—The lettuce secretes a well known milky fluid, which, when exposed to the air, hardens and forms the drug known as lactucarium. Although this juice is strongly narcotic, *L. virosa* is probably not poisonous to man, in spite of its specific name, and its properties, like those of many other plants, have been greatly exaggerated. As an injection the juice seems, however, to have more power, and 36 grs. injected into the jugular vein of a dog killed the animal in fifteen minutes.

Some of the Compositæ are poisonous to insects, notably (*Chrysanthemum roseum*), which gives "Persian powder," and (*C. rigidium*), which furnishes "Dalmatian insect powder;" and our own oxeye daisy, *Chrysanthemum leucanthemum*, and fleabane, *Inula dysenterica*, are said to be destructive to fleas.

(LOGANIACEÆ.)—Although this order is chiefly tropical and not represented at all in our latitudes, I cannot pass it over unnoticed, as it is eminently poisonous, and affords some of the most toxic drugs known. (*Strychnos nux vomica*), a native of Ceylon, produces fruit the size of an orange, the flattened orbicular seeds of which contain, in great quantity, two violent poisonous alkaloids, strychnine and brucine, which are largely used in medicine. This plant has a representative in the Philippine Islands, in (*S. Ignatii*), the seeds of which, under the name of St. Ignatius beans, are largely used for the manufacture of strychnine. Strychnine is perhaps, after prussic acid, the most virulent of poisons. It kills in a few minutes, and its victims perish after horrible contortions. As already stated, it has no effect, directly applied to nervous tissue. From the bark of (*S. toxifera*) of Guiana is prepared the dreaded "Wourali" or "Curare" poison, and for a most interesting account of its preparation, uses, and properties, I refer the reader to Charles Waterton's "Wanderings in South America." This enthusiastic naturalist made several visits to the Maconshi Indians, of Guiana, with the chief object of collecting some of the poison. As most of the species of this genus are highly toxic, it is remarkable that the fruit of one of them, (*S. potatorium*) of India, has the curious property of making foul and muddy water quite clear and drinkable, if the seeds are simply rubbed round the inside of the vessel containing the water. It thus plays in India the same part as the kola nut is said to do in Africa.

SOLANACEÆ.—A widely distributed group of plants, characterized by their generally dangerous and narcotic properties. In some species a certain part of the plant may be edible, or even very wholesome, while all the other parts retain more or less narcotic properties. The tomato is an instance; while the leaves, stem, and fruit of the potato are strongly narcotic, and the tuber itself, when grown in the air and light, becomes poisonous. Death has actually taken place from eating this vegetable grown in such conditions.

Atropa belladonna.—The dwale or deadly nightshade is, perhaps, of all our poisonous plants, the one best known to be so, and on this account cases of people being poisoned by it do not more frequently occur, for otherwise its berries are not unattractive, especially to children. Its active principle resides in a narcotic alkaloid, atropine, which is present throughout the plant, but in larger quantity in its dark purple, cherry like berries. These are highly toxic: very few of them will cause certain death, and even half a berry has sometimes proved fatal to children. The whole plant is so poisonous that merely carrying it for some time has been known to cause temporary paralysis of the hand. Atropine has, besides, the peculiar and useful property of dilating the pupil of the eye.

Solanum dulcamara nigrum.—The bitter-sweet and the common nightshade are also more or less poisonous, according to the quantity of solanine their sap may happen to contain—this seems to be very variable. The alkaloid solanine is most readily obtained from the sprouts of potatoes.

Hyoscyamus niger.—The henbane, the active principle of which is the alkaloid hyoscyamine, is not uncommon in England. It is a dangerous plant for man to eat, but not so to cattle, horses, or swine. Horses have been given one to two pounds of the plant without any evil effects. The most powerful parts of the plant seem to be its leaves and seeds, and they will soon cause, in man, giddiness, stupor, and delirium, but seldom death. As a remarkable instance of its effect, I may quote a case, recorded by Dr. Houlton, in which the roots were eaten by the inmates of a monastery for supper. All who had partaken of them were more or less affected during the night and following day. With some, the actions induced were rather ludicrous. One monk got up at midnight and tolled the bell for matins, while of those who obeyed the summons, some could not read, others repeated what was not in their breviaries, and many were seized with the strangest hallucinations. By injection of the extract the henbane becomes toxic to a higher degree, and it then affects even animals otherwise not subject to its influence.

(*Datura stramonium.*)—Though not a native plant in Britain, the thorn apple is sometimes found as an "escape," in the neighborhood of gardens. The whole plant has an unpleasant, stupefying smell and is highly toxic; in fact, it is the most poisonous of the nightshade tribe. The action which this plant exerts on the nervous system, the delirium it causes, and the hallucinations it gives rise to, explain the effects obtained by its means by the sorcerers of the middle ages, and which earned for it the name of devil's apple. Another species of *Datura* "was used by the priests of Delphi to produce those semi-delirious paroxysms which they palmed off on the multitude as the results or manifestations of divine inspiration." The plant contains, in its juice, two alkaloids, daturine (atropine) and stramonine.

(*Nicotiana tabacum, N. rustica*, etc.)—Tobacco also belongs to the products of this order. It is rich in an oily alkaloid, nicotine, which is a very strong narcotic-irritant poison. One single drop, placed on the tongue of a cat, killed it in two minutes, and two drops injected into a dog speedily caused its death. In its effects on the nervous system, nicotine is directly opposed to strychnine, for while the latter excites the nerves up to a tetanic condition, nicotine decreases the activity of the nervous system, and it therefore proves a most efficacious remedy against tetanus. On the other hand, tobacco agrees with nux vomica in the peculiarity of producing no effect if applied directly to the nerves. Nicotine has produced serious poisoning by being merely rubbed on the skin, and all smokers know its effects when its vapor is inhaled for the first few times. It soon, however, loses its toxic effect on the smoker (unless smoked in excess), and its peculiar, soothing, and grateful influence only remains.

(To be continued.)

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